POWER PLANT ENGINEERING

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Features of Plant Constructed for War Purposes

MILL OF ERIE FORGE & STEEL CO. FURNISHED STEAM AND COMPRESSED AIR BY MODERN BOILER PLANT

DURING THE DEMAND in 1917 for war materials and yet more war materials, the Government sought the aid of the Erie Forge & Steel Co. to build a factory for the manufacture of steel forgings for the navy. The plant was constructed under the stress of the war in about 7 mo., but does not in any particular resemble a temporary plant and was taken over by the Erie Forge & Steel Co. a few months after the armistice was signed.

One of the features of the factory is the power plant which supplies the steam and compressed air needed in turning out heavy forgings such as ship shafting, crankshafts, etc. Electric power is supplied from the central station for whatever purpose it may be used, the principal units in the power plant driven by electricity being two air compressors. These are two-stage compressors, each having a capacity of 1500 cu. ft. of free air per min. when working against a delivery pressure of 100 to 110 lb. The cylinders are 14 by 16 in. and 22 by 16 in , being connected through an intercooler and water jacketed. On the discharge of each cylinder is a relief valve, the low pressure discharge being at 20 lb. The intake pipes come from outdoors where a hooded and screened inlet is provided, and after compression the air is delivered to an air receiver placed just outside the wall.

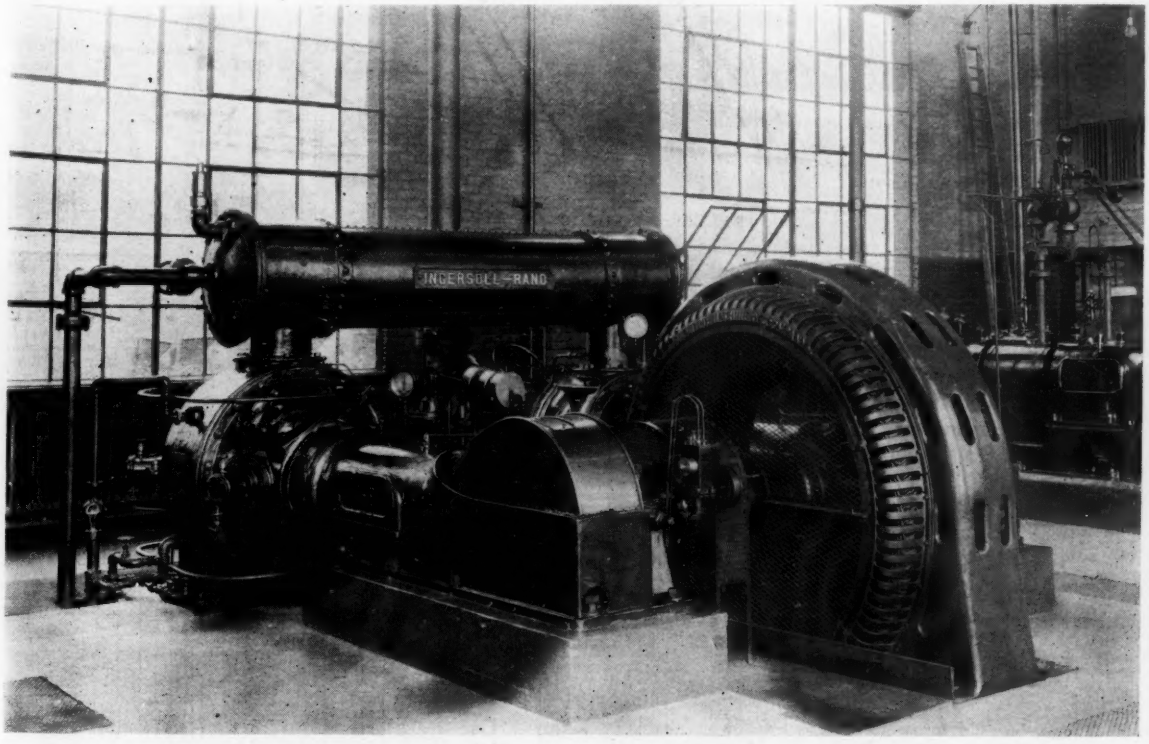


FIG. 1. AIR COMPRESSORS IN THE ERIE FORGE & STEEL CO.'S PLANT

Several features in the design of these compressors are interesting, as they indicate the trend of modern practice. In the matter of lubrication, for example, the flood system is employed for supplying a stream of oil

to the main bearings, crankpins and crosshead pins. The oil basins are located in the main frames and surround the lower part of the crank disks. When the compressor bearings return by gravity to the crank basin to be used over and over again. A partial plate in the main frame casting, with an auxiliary stuffing-box, prevents the oil

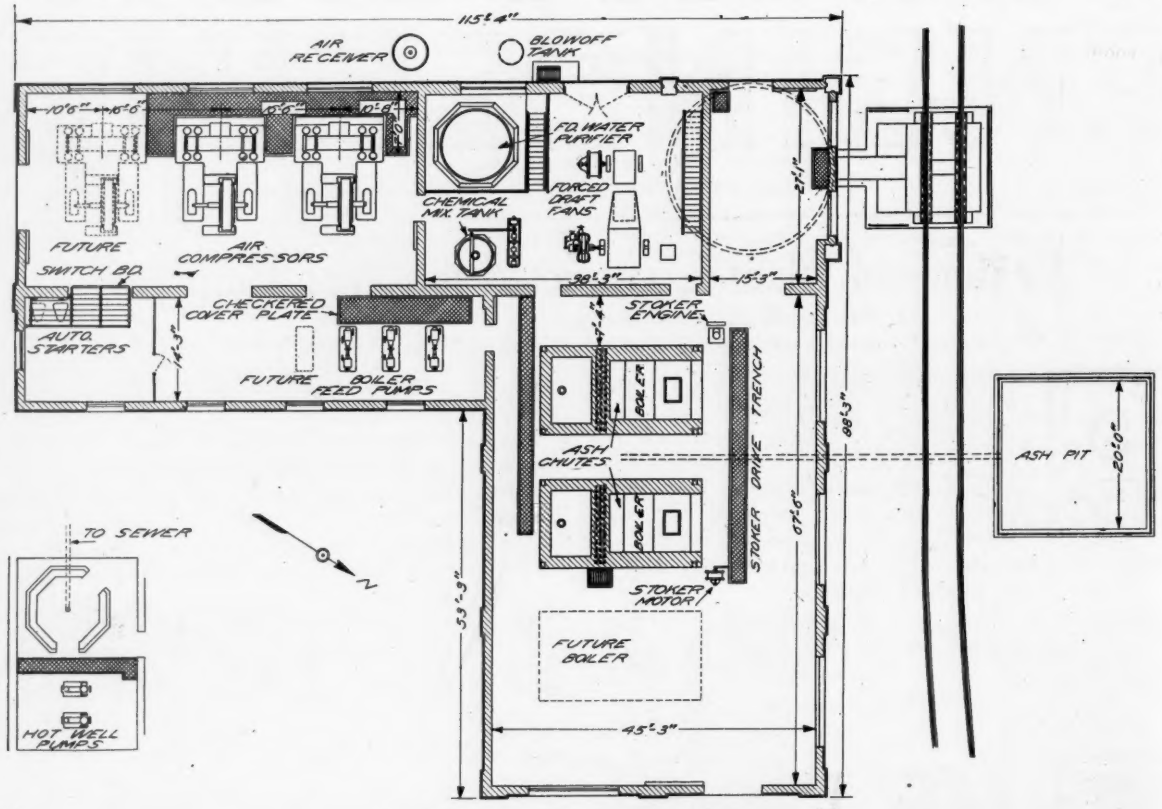


FIG. 2. LAYOUT OF PLANT EQUIPMENT

is in operation a small quantity of oil adheres to the edges of the disks and is carried to the top of the disks where it is caught in wipers which discharge into pans. From the pans, pipes deliver the oil to the main bearings, crank and crosshead pins, crosshead guides and piston rods. A constant flow continues as long as the compressor is in operation and the drippings from these

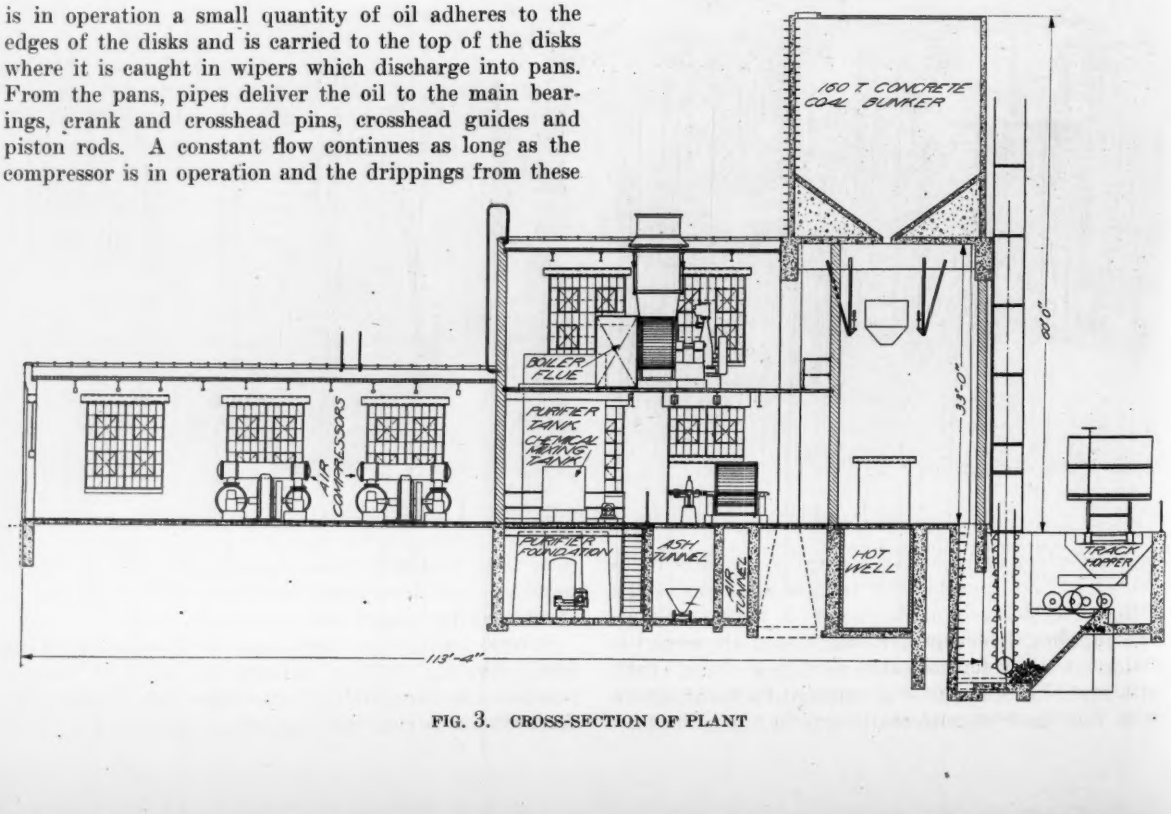


FIG. 3. CROSS-SECTION OF PLANT

from being drawn into the air cylinders along the rods, while giving access to the cylinder stuffing-boxes. Lubrication of the air cylinders is effected by mechanically operated force feed pumps.

As previously stated, each cylinder is water jacketed, the cooling water being divided into three streams, one entering the bottom of the cylinder jacket and the other two entering the bottom of each head. The discharge from the jackets is from the side of the cylinder and the

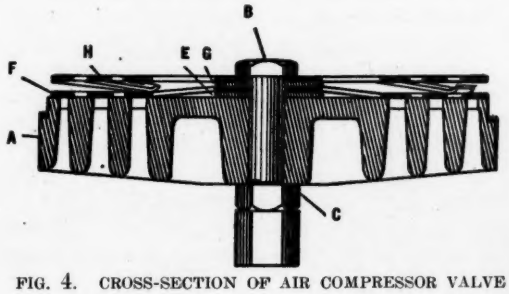


FIG. 4. CROSS-SECTION OF AIR COMPRESSOR VALVE

tops of the ends with piping leading to an open funnel connected to the drain pipe.

The air valves are of what is known as the plate type, a section of which is shown in Fig. 4, A being the valve seat, B and C the valve nut and bolt, which holds the valve parts together, E is a washer placed between the valve seat and the valve proper F, G is another washer which separates the valve and stop plate H. Between the fixed and moving sections of the valve proper

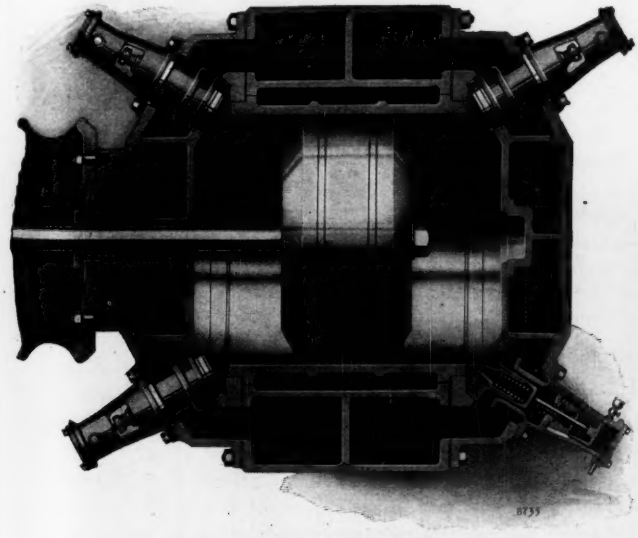


FIG. 5. SECTION OF AIR COMPRESSOR CYLINDER SHOWING LOCATION OF CLEARANCE POCKETS

are connecting arms, circular in form and of light spring material, which serve to hold the valve in one position latterly and seat it always in the same place. Four spring arms hold the valve to its seat, when the piston is at rest, against the slight tension of the integral valve arms; when the air pressure required to open the valve is reached, these four springs are deflected and the valve opens to the full extent. As soon as the piston comes to rest, the air pressure on both sides of the valve instantly equalizes and the valve closes. As no rubbing parts are used, no lubrication is needed.

One of the distinctive features of the intercooler is a moisture trap located in the intake to the high-pressure cylinder which catches the water precipitated from the air by the cooling process and delivers it to a drip tank through a small pipe, whence it is blown to the common drain whenever necessary by the operator.

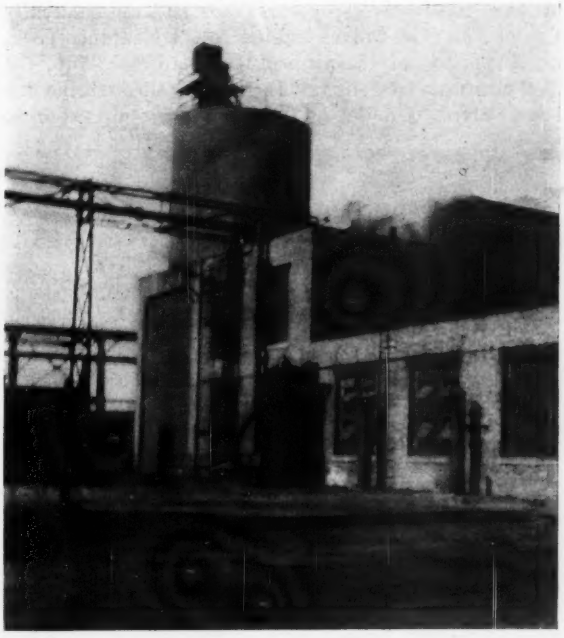


FIG. 6. AIR INTAKE, COMPRESSED AIR RECEIVER, TRANSMISSION PIPE AND COAL STORAGE BINS ARE SHOWN HERE

In the operation of direct-connected motor driven air compressors, regulation is of extreme importance. To accomplish this with a constant speed motor, something more than the ordinary relief valve must be provided if economy is to be secured. In these compressors, clearance pockets are employed, four being provided for each

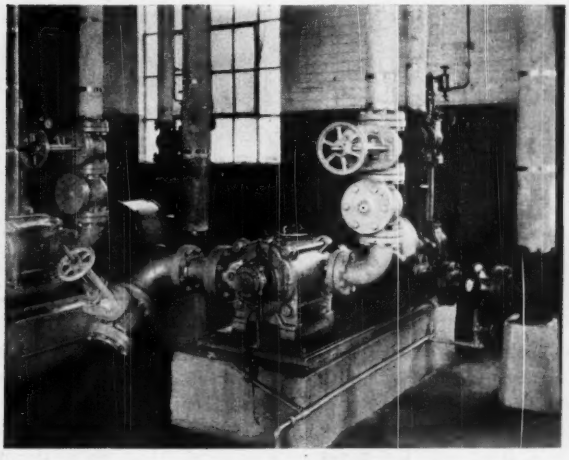


FIG. 7. TURBINE-DRIVEN BOILER FEED PUMPS

cylinder located as shown in Fig. 5, each pocket having a capacity equal to half the piston displacement per stroke. By this means, regulation is obtained in five stages, viz: full load, three-quarter, half, quarter and no load.

In operation, when the demand for air falls below full load, the receiver pressure rises and automatically opens one or more valves leading to the clearance pockets. A portion of the air is then compressed into the added clearance space instead of passing through the discharge valves. On the return stroke, this air expands, giving up its stored energy until inlet pressure is reached in the cylinder when the inlet valves open and remain open until the end of the stroke is reached and the cycle repeated. Clearance space is added simultaneously to both high and low-pressure cylinders, thus maintaining a constant ratio of compression throughout the entire load range.

The motors for driving these compressors are rated at 300 hp. and are of the synchronous type. They operate at a speed of 225 r p.m. on 60 cycle, 3-phase current at 440 v., with a rating of 316 amp. per terminal.

The switchboard for controlling the current to the compressor units consists of three panels upon which are mounted a power factor meter, two a.c. ammeters, two d.c. ammeters, circuit breakers and three wattmeters.

Among the interesting features of the plant are the three turbine driven centrifugal boiler feed pumps. The turbines are run at 3300 r.p.m., on a steam pressure of 150 lb. and exhaust against a pressure of 7 lb. The pump end has four stages and has a capacity of 150 g.p.m. at 520 ft. head. The pumps are automatically controlled by feed-water regulators and have given the very best of service.

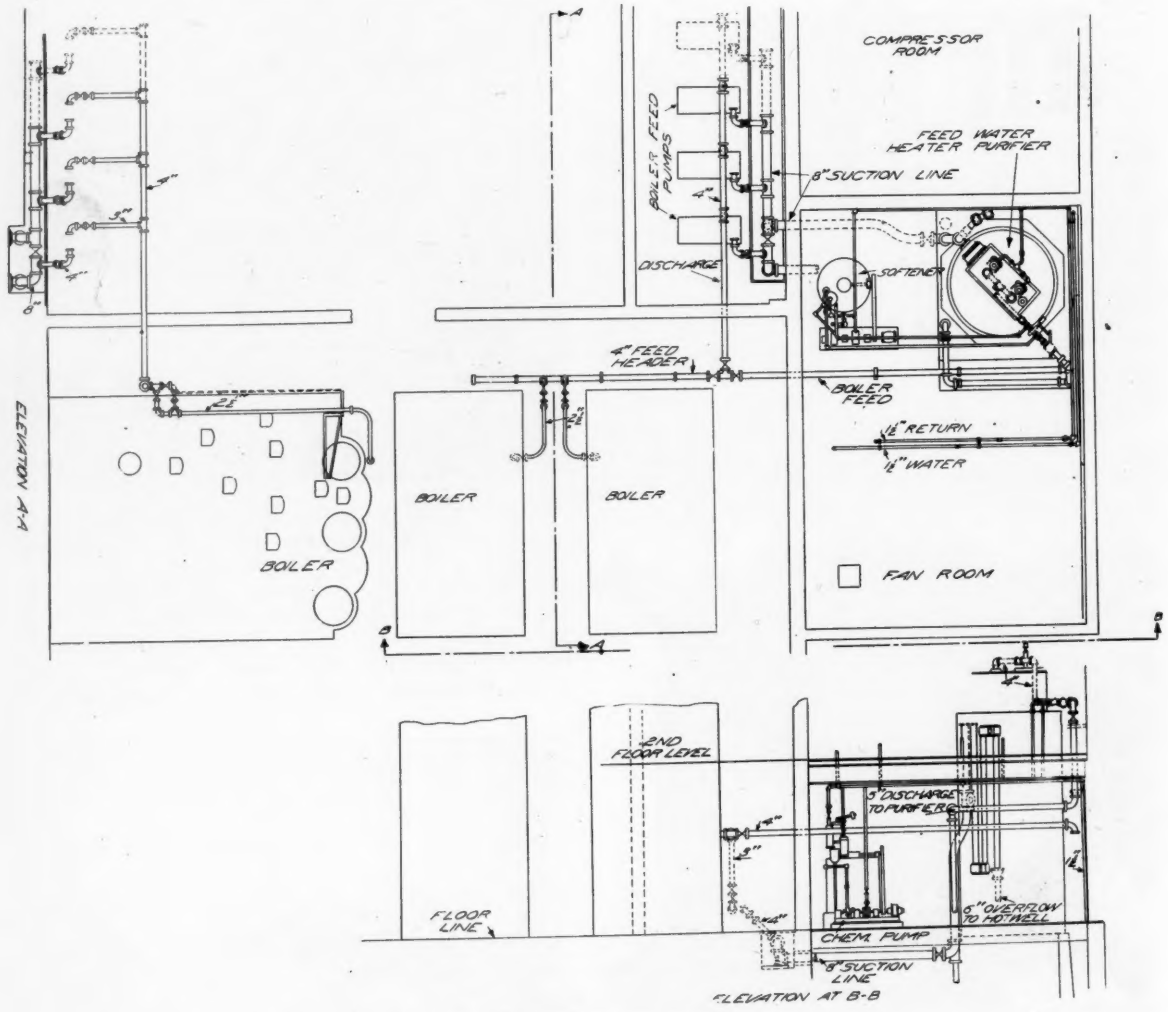


FIG. 8. FEED WATER PIPING

All heating returns and high-pressure drips and heated cooling water from the doors of the open hearths, which has a temperature of about 180 deg., return to a hot well located in the basement of the plant. This is made of reinforced concrete, and has a capacity of 13,000 gal. and is provided with an overflow to the sewer. From the bottom of the tank the water flows by gravity to the heater pumps. These are two in number with 6-in. steam cylinders, 7½-in. water cylinders and 6-in. stroke. In the suction line to each of these pumps is a strainer.

The pumps discharge to the heater under float control. A system of water treatment is employed wherein

the water is heated before it is chemically treated, thus causing more rapid precipitation. Lake Erie water is used for feed purposes and is treated with lime and soda ash. In the operation of the softener, the water is tested six times daily and the chemical proportioner adjusted accordingly. The capacity is 9000 g.p.-hr. and the temperature 205 to 218 deg. F.

At present, two boilers are installed in the power plant with provision for one more in the building which, however, is also designed for further extension as the need presents itself. Each of the boilers has a rated capacity of 500 hp., inclosed in separate settings, served by five-retort underfeed stokers, and operate at 155 lb. pressure. They are vertical water-tube boilers with soot blowers built in the settings. In each boiler blowoff line is a mechanical cock and an angle blowoff valve which discharge into a blowoff tank located outside the building. The water level is maintained by a constant flow feed-water regulator.

The stokers are driven regularly by a vertical engine, 5 in. diameter by 6 in. stroke, running at a normal speed of 400 r.p.m. under a pressure of 155 lb. The speed of the engine is controlled automatically. As an auxiliary drive a motor is provided, the speed of which, however, is regulated by hand. The line shaft from which the stokers are driven is located beneath the floor with connections to the engine, motor, and stokers through silent chain drives.

Two induced draft fans are installed, one being used as an auxiliary at present. One fan is driven by a turbine through a reducing gear and the speed is automatically controlled by the pressure of the steam in the boiler. The other fan is driven by an electric motor rated at 40 hp., taking 3-phase current at 60 cycles and 440 v. This fan is hand-controlled, as it is used only as an auxiliary. Each of the stacks is 5 ft. in diameter and extends 40 ft. above the grates, which is only a few feet above the roof of the building.

There are two forced-draft fans; the one being used regularly is driven by a turbine, the auxiliary fan by a motor which, at rating, runs at 810 r.p.m. on 3-phase, 60 cycle current at 440 v.

Regulation of the steam-driven forced and induced draft fans is accomplished by means of a water-operated damper regulator which is so constructed that it will hold the regulating valves at the position that will give the desired speed to the turbines and fans, accomplishing the results gradually yet with a precision that will insure a steady steam pressure and the best furnace conditions.

The speed of the motor-driven forced-draft fan is also automatically controlled by a regulator attached to the rheostat on the control board so that the air supply varies directly with the load carried as reflected in variations of steam pressure.

Coal comes to the plant in bottom dump cars and is discharged directly to the hopper of a crusher through which it passes to the bucket elevator which carries it to reinforced concrete bunker on the roof of the building. This bunker has a capacity of 160 tons and feeds directly to a traveling larry and scales in the boiler room. This gives an accurate account of all coal being used.

From the two boilers the ashes are delivered on slides to the steam-jet ash conveyor that discharges them to a pit in the yard. This pit is of concrete 20 ft. square by 11 ft. deep and is so located that a clamshell crane is used to load ashes into railways cars.

As stated previously, this is essentially a steam generating plant, the steam being used for various purposes about the plant and factory, electric power being furnished from an outside source. In addition to the two boilers in the power plant proper, there are two 500-hp. vertical water-tube boilers in one of the mill buildings which generate steam from the waste heat from the open hearth furnaces, but are also equipped with dutch oven furnaces for the burning of either fuel oil or coal as auxiliary fuel. The waste gases come to the boilers at a temperature of about 1100 deg. F., being drawn through the boiler by means of an induced-draft fan. The pressure carried in these boilers is 155 lb. and the steam feeds into the main line from the power plant.

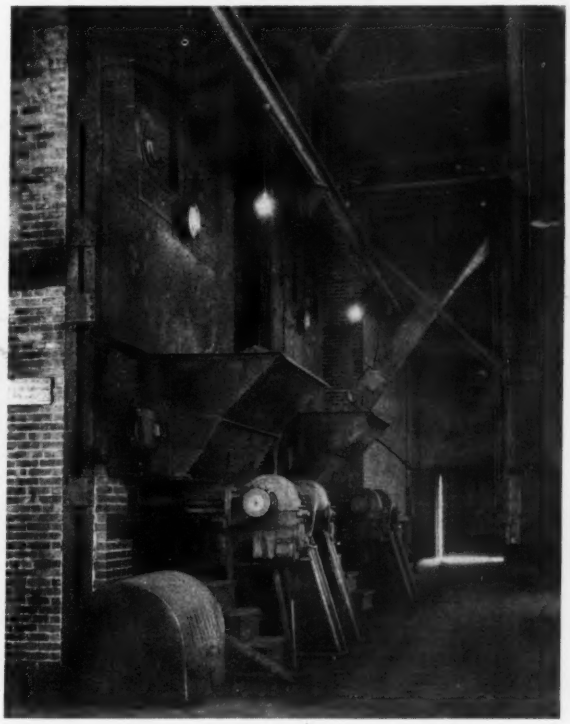


FIG. 9. BOILER ROOM VIEW

A RECENT British invention has been made whereby the piston of an internal-combustion engine may be cooled by means of a draft of air circulating through a space in the piston. The draft is provided by means of fan blades on the engine flywheel. On either side of the hollow piston are ports which register the corresponding ports in the cylinder walls at the end of the stroke. A draft of air is thus forced through the hollow space in the piston while all the ports are in line.—Compressed Air Magazine.

U. S CIVIL SERVICE COMMISSION announces an examination, July 27, for electrical engineer to fill a vacancy at the U. S. Naval Ordnance Plant, South Charleston, W. Va., at $14 a day, and vacancies in positions requiring similar qualifications, at this or higher or lower rates of pay. Apply for Form 1312.

Revising Old Steam Heating Systems

Bringing Old Types of Traps and Valves Up to Date by Means of Sylphon Attachments

PROGRESS IN the development of steam heating systems, as in almost every other branch of engineering, is due largely to the accumulative results of experience. The old-fashioned gravity system is unsatisfactory and is rapidly disappearing in favor of more improved systems. Its disadvantages and high operating cost become so apparent in time, that the owners have realized the necessity for modernizing their heating plants.

One of the foremost problems in the development of steam heating systems has been that of keeping steam in the radiators and coils until it has fully condensed and at the same time, permitting free escape of air and condensate into the return lines. For, unless there is continuous removal of air and the products of condensation, such systems are inefficient; and if steam is wasted into the return lines, they are uneconomical.

The distinguishing characteristic of most of the modern systems of steam heating is found in the trap on the return end of the radiator. As a matter of fact, these systems are all alike except that the type of trap employed differs somewhat in construction, in principle of operation, and in the efficiency.

In recent years, the market has been flooded with various types and makes of radiator traps, vacuum return valves, etc., many of which have disappeared from the market after a brief existence. The owners of buildings in which such traps or valves are installed are unable to obtain repair parts, or to remedy troubles and difficulties without complete substitution of the apparatus, and this frequently involves extensive changes in piping, which are expensive.

A good trap for a vacuum system must: (1) prevent all escape of steam into the return riser, (2) allow all condensate and air to escape from the radiator, (3) be quiet in operation, and, (4) be free from fouling due to scale, grit, etc., which may prevent proper seating when the trap closes.

An excellent type of trap which meets with the foregoing requirements and which is applicable to widely varying pressures, is known as the sylphon trap. It is thermostatic in principle, operating under the influence of an expansion bellows which contains a volatile liquid. This trap is shown in Fig. 1.

The operating member consists of a metal bellows containing a volatile liquid, which carries a conical valve piece closing against a sharp-edged seat. The bellows element is very sensitive, operating to open or close the valve port by the slightest change in temperature. The numerous corrugations in this bellows allow for a large lift of the valve from the seat, thus permitting dirt that would lodge in most valves, to pass through the port.

This type of valve has been in great demand and for the purpose of bringing old heating systems up to date at a moderate expense, a number of sylphon attachments have been developed. These attachments enable not only types of traps of earlier models, but the ordinary type of hand-wheel shutoff valve used on old gravity systems as well, to be converted into sylphon traps in a few minutes without breaking or touching pipe connections.

The use of these sylphon attachments properly applied throughout the building, will often effect the same advantages as extensive changes in piping, and, furthermore, the whole work of change can be done without interrupting the operation of the system as a whole.

The attachments are made in two general forms. One (Fig. 3) in which the attachment parts are fitted in an extension body which screws into the old trap or valve body, and the other (Fig. 2), in which the attachment parts are fitted into a special brass cap which is threaded to fit the old valve or trap body.

The extension bodies are made with a threaded opening at the top to receive a standard cap but of varying diameters of the lower part of the body so that the lower end may be threaded to fit the thread of the old body. They are made in a number of different shapes and sizes to accommodate different makes of valves or traps.

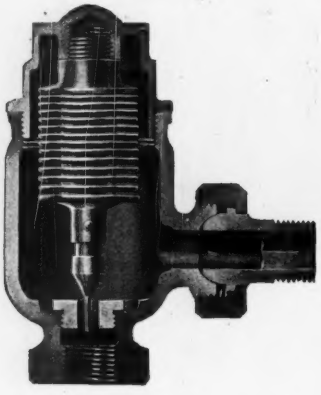


FIG. 1. SECTION OF SYLPHON TRAP

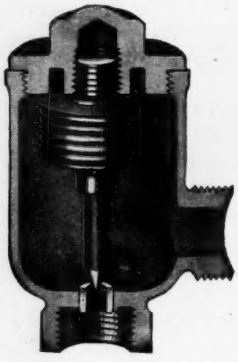


FIG. 2. SYLPHON ATTACHMENTS APPLIED TO OLD VALVE BODY WITHOUT USE OF EXTENSION BODY

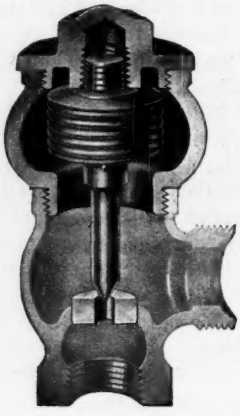


FIG. 3. SYLPHON ATTACHMENT WITH EXTENSION BODY

The valve stem attached to the bellows varies in length with the type of valve body, but is of similar design in all cases.

The seat is made to push-fit into the body opening which is previously prepared by reaming, if necessary, to the desirable diameter. To meet any variation in the depth of the valve body, the seat is forced in place by means of a special push-in tool.

The valve stem is a solid brass rod with a conical taper or seating and is made of varying length, determined: (1) by the gage depth of the old body from bonnet face to seat, (2) by the diameter of the orifice in the seat, and (3) by the rating of the radiation unit to which the valve is connected.

required: the guide bushing, the reamer, which is used to ream out the seat opening to the proper diameter, and the push mandrel or push-in tool for setting the new seat. The push-in tool also fits into the guide bushing and is made to avoid any chance of error in pushing the new seat into place.

The method of installing the extension type of attachment is as follows:

The cap, operating parts, and seat are first removed from the old valve, and the extension piece screwed on. Insert the guide bushing and into this guide bushing insert the reamer. After reaming the old seat for the new seat bushing, clean out the chips and dirt resulting from the operation and insert the push seat into the new opening by means of the push mandrel. Force the push seat home in the old valve body by screwing down the guide bushing. Now, remove the guide bushing and push mandrel and clean the cap face. Insert the bellows member and complete the operation by screwing the cap home.

The successive operations described in the preceding paragraph are illustrated in Fig. 4.

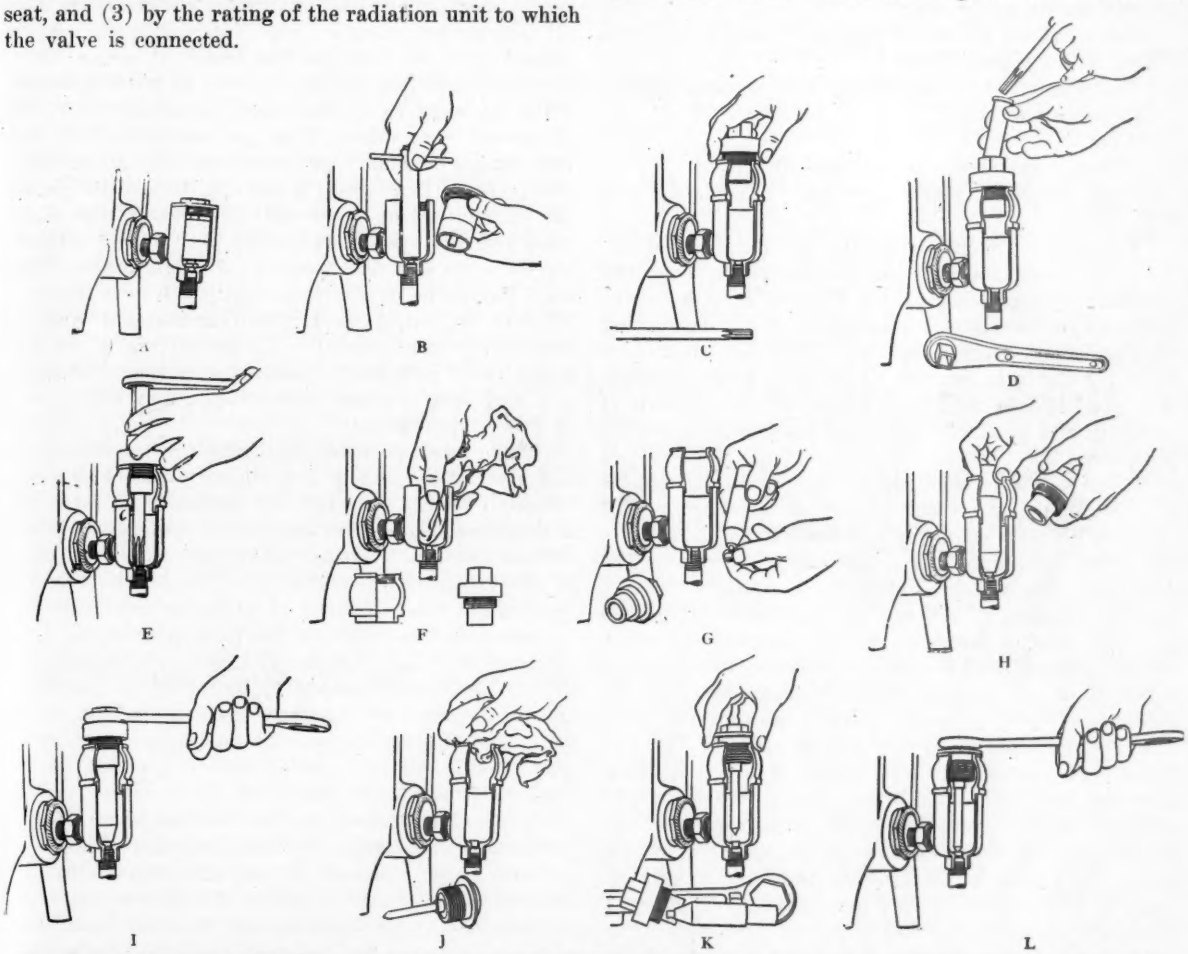


FIG. 4. SUCCESSIVE OPERATIONS REQUIRED IN INSTALLING EXTENSION TYPE OF ATTACHMENT. (A) OLD TRAP. (B) REMOVE OLD CAP, OPERATING PARTS AND SEAT. (C) INSERT EXTENSION PIECE IN OLD BODY; THEN INSERT GUIDE BUSHING. (D) INSERT REAMER IN GUIDE BUSHING. (E) REAM OLD SEAT FOR NEW BUSHING. (F) CLEAN OUT CHIPS. (G) INSERT PUSH MANDREL IN PUSH SEAT. (H) INSERT PUSH SEAT IN NEW SEAT OPENING. (I) FORCE PUSH SEAT HOME. (J) REMOVE GUIDE BUSHING AND PUSH MANDREL AND CLEAN CAP FACE. (K) INSERT SYLPHON MEMBER AND CAP. (L) COMPLETE OPERATION BY SCREWING CAP HOME.

In cases where the old valve or trap body is sufficiently large to accommodate the expanding member and conical valve piece, the use of the extension body is dispensed with as shown in Fig. 2. With this class of attachment it is necessary to provide a special cap, threaded to fit the existing body, but the design has been standardized so that few patterns need be used to meet a wide variety of bodies.

The actual installation of the attachments, when fully understood, is a very simple matter. Only three tools are

Personnel Work Applied to Public Utility*

THE VALUE AND ESSENTIALS OF A SUCCESSFUL PERSONNEL DEPARTMENT IN AN ORGANIZATION. BY J. E. SHUTE†

WHEN I hear men tell of the personnel organization that they have established, who seem to be convinced that it is the only one in the world, I sometimes feel that they may be right insofar as their organization is concerned, but insofar as other organizations are concerned they remind me of an instance enacted on the golf links:

Jones handed his driver to a professional and said, "Ted, is this a good driver?"

Ted wiggled it, took a swing with it, and replied, "Can you hit with it?"

"Yes."

"Then," said Ted, "it is a good driver."

"But, Ted," the golfer inquired, "can you hit with it?"

Ted said, "I couldn't hit the side of a house with it," which brings out my point that what I say about our personnel organization as we view it, may be of no value to you whatsoever, because it is our belief that each personnel department should be designed particularly for the organization in which it is to function. Any good human machine that will develop a spirit of harmony and good-will is a good machine if it accomplishes results.

Prior to the creation of the personnel department in our organization, each foreman or department head engaged his own employes and discharged them; as a matter of fact, they had entire charge of them. The new plan was a radical change. It brought up that familiar question of curbing the prerogative of the department head or foreman. In the matter of discharge, the department head or foreman retained the authority to discharge any employe from his department, but the superintendent of personnel is the final authority as to whether the employe leaves the organization or not. Those who feared that they would be shorn of their authority now believe that the company has materially benefited by the centralization of employment and discharge and are enthusiastic over the operation of the plan. They fully appreciate that the system of employment, as established now, is a part of their own creation. They are no longer troubled with the duties incident to employment: investigation of recommendations and personal data.

The administration of the personnel department is to encourage the organization to take up with them their troubles, whether they relate to their work or are purely personal matters. The organization was rather slow to come to the department with their personal affairs, due, no doubt, to lack of familiar acquaintance, and ofttimes embarrassing subjects. This is gradually being overcome, and we, at all times, try to impress on the employes that they have a friend on whom they can lean in the organization.

We do not advocate or apply welfare work along the line of parentalism, but try to apply the Golden Rule and a square deal for all.

We believe that the reward for loyalty and good service must be in the pay envelope. You can have play grounds, libraries, cafeterias, group insurance, beneficial organizations, and various other plans to promote contentment, but unless the employe receives good wages all this welfare work is lost. You will often hear the remark, "If we could get the money in wages that is spent for these fool things, we would be better satisfied." I do not want to be understood as saying that these things are of no value. They are sometimes very essential, but are secondary considerations from an employe's viewpoint. Therefore, it is the first duty of the personnel superintendent to see that his organization is well paid and the first effort on the part of the employer should be to establish a contented organization. When good pay is the incentive, naturally you have many applicants for employment, which means that employes can be carefully selected. If the reverse is the fact, wages below standard, no matter what other attractions you may have to please the employes, they will be more or less unappreciated.

There must be some intelligent way to reward patience, devotion, loyalty and efficiency, otherwise we deliberately reward the noisy and aggressive for their noise and aggressiveness. Are not loyalty, efficiency and faithfulness measurable virtues which have a financial value to the employer? We believe they are and have devised and have in effect a method of rating our employes. The rating system is based on the principles of the U. S. Army system, modified to suit our own needs. This system has been developed by determining what qualities in a worker are assets to the organization. After a very careful study, we have determined that intelligence, skill, initiative and personal qualities are the primary factors to be considered.

Under intelligence, we consider readiness of comprehension and ability to learn rapidly; under skill, accuracy, speed, interest in work and adaptability; under initiative, alertness, originality of conception and independent and prompt action, particularly in cases of emergency, and the readiness to shoulder responsibility for action; personal qualities are defined as, obligation of duty to the company, spirit of co-operation, reputation, common sense, discipline, veracity and sense of right.

Semi-annually every member of the organization is rated according to this rating scale. The rating is not done on a percentage basis, but is on a basis of a man to man comparison, expressed in numerical values. For instance, we compare firemen with other firemen, linemen with other linemen, but never make comparisons out of the particular line or class of work they are engaged in. The qualities that we have named before, each carry with them a numerical value, but do not carry a percentage value. Each employe is rated by two superiors, known as the rating authority and revising authority. The rating authority is the employe's imme-

* Abstract of paper delivered before the Industrial Relations Association of America.

† Assistant to general superintendent of the Penn Central Light & Power Co.

diate superior, as the foreman; the revising authority is the rating authority's immediate superior, as superintendent of lines, etc. This means that every man will get a square deal, due to the fact that a foreman, rating a man low, and his immediate superior, rating the man high, informs the superintendent of personnel, who is the final recipient, that there is either favoritism or poor judgment used in the rating. However, this is no cause for worry, as it is simply a matter of getting the superintendent and foreman together and determining the cause of the diversity.

These ratings are strictly confidential and are known only to the rating and revising authorities and the management. However, the qualities that the employes are rated on are known to every member of the organization and we believe that the psychological effect is increased interest in their work.

We have, through this plan, reduced our labor turnover from 122 per cent for the year prior to the operation of the personnel department to 24.3 per cent for the first ten months of its operation, at a cost which we believe is at a minimum.

A personnel department is a success when the workers are satisfied, contented, living under decent circumstances, working earnestly and honestly with the organization and willing to back it up in an emergency.

The time has about arrived, as Chas. Dickens phrased it, "When men and women seem by one consent to open their shut-up hearts fully and to think of people below them as if they really were fellow passengers to the grave, and not another race of creatures bound on other journeys." After all is said and done, regardless of success or failure, we are all human and both success and failure are due to human interest or to the lack of it.

Coal Storage Saves Money for Many Plants

By Guy S. Hamilton

A LOSS of $3,800,000 a day can be attributed to the unauthorized railroad strike, is the estimate of Julius H. Parmelee, Director of Railroad Economics.

He states that the railroads are losing $3,000,000 a day and the railroad employes are losing in the neighborhood of $800,000.

Mr. Parmelee is more concerned with the loss to railroads and railroad employes. His figures do not take into consideration the loss to manufacturers and consumers. Lack of coal alone has caused a huge loss to industry in general.

During the height of the strike the papers were filled with items telling of huge losses. One hundred thousand men in Detroit alone were thrown out of work. Ford's, with a payroll of 20,000 men, were forced to close. These are but typical of conditions in various parts of the country.

But not every plant was forced to close down. Even in towns where the coal shortage was acute, many ran full time.

Why? The answer is coal storage. The plants that continued to operate were plants that had installed coal handling machinery and stored up a good supply of coal.

Coal storage is the best sort of plant insurance. It pays dividends in steady production.

The miners' strike last fall taught many power plant executives the value of coal storage. The switchmen's strike has served to drive home the lesson.

As one executive put it: "Our plant was equipped with handling machinery to carry coal from the cars to our overhead bunkers but there was no provision for storing coal. We operated on a car-to-car or week-to-week basis.

"Now we have learned our lesson. We are going to put in equipment that will not only elevate coal to the bunkers, but will also carry coal from the cars to the pile to the bunkers. We're going to carry on hand a supply of coal that will keep our plant going for several months."

One type of equipment designed to meet these conditions consists of a trolley and bucket with monorail track operated by a hoist using as power an electric motor, gasoline or steam engine.

The operation of the carrier is simple. As a coal car is received on the siding it is "spotted" into place over a shallow track hopper having a bottom inclined at an angle of approximately 45 deg. At the lower end of the hopper is a duplex undercut gate. The coal is withdrawn through the gate into a bucket having a capacity of one ton. On each side of the bucket loading pit are rails. As the hoist operator lowers away the bucket, small wheels on its side engage on the track and guide the bucket to a position in front of and directly beneath the gate. When the bucket is filled, the hoist operator closes the gate, elevates the bucket to a point directly beneath the trolley and then conveys it to the disposal point.

Since the bucket is self-dumping and self-closing, the hoist operator is not obliged to move from his position at the hoist during any part of the operation. He can, therefore, work with unusual speed and ease. An average of 30 tons an hour is handled; five or six cars can be emptied daily.

Such a carrier as this is flexible and can be adapted to practically any power plant. It can also be used to handle ashes from the boiler room to pile outside.

This is only one of a number of types of coal carriers that can be used to build up a good store of coal. The big point to be remembered is the importance of coal storage. It should not be overlooked, but investigated at once.

If your power plant is working on a limited coal capacity you will do well to consider thoughtfully the coal storage situation at once. Do not be caught short.

Terence was called upon to pack a heavy motor. The only receptacle he could find was a large barrel. After packing it, he feared that the ends were too frail to hold it, if stood upright. The only stencils he had read:

"This End Up."

"This End Down."

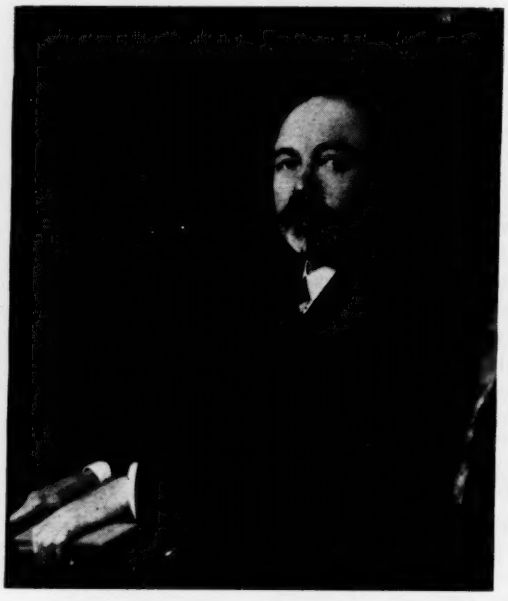
His quandary did not last long. He seized a marking pot and inscribed at each end:

"Lay it on its belly."

MARTIN T. KIMMAN

LOCOMOTIVE FIREMAN, WHO WORKED UPWARD THROUGH LONG AND VARIED ENGINEERING SERVICE. NOW SUPERVISES THE PLANTS OF SIX OF CHICAGO'S PROMINENT BUILDINGS. BY WALTER PAINTER

ATOP THE McCormick Building in Chicago, in a spacious office overlooking the lake, works a man whose ambition to become a successful engineer was never dimmed by the warm, smoky hours of the boiler room nor by the years crowded with daily engine wipings and routine switchboard readings. To his varied experiences was added the purposeful study of books dealing with indicator diagrams and many other phases of power plant operation. Steadily but surely Mr. Kimman developed larger ability and today he is supervising engineering for the L. J. McCormick Estate, for which he is now completing 30 years of continuous service. Under his mature direction are operated the power and heating plants and the maintenance departments of six large buildings.



Martin T. Kimman

As Mr. Kimman was only five years old when he came with his parents from Holland to Chicago, the fascinating hum of the engine room had not yet influenced his choice of a career. His father and several elder brothers were expert machinists and as young Martin frequently worked as helper, he soon became skilled in handling the lathe and drill press. At the age of fourteen, with the aid of a brother he built a 15-ft. boat and fitted it with a water-tube boiler and a 15-hp. engine of their making. The engine was 2¼ by 4 in. with double cylinders and regular slide valve gear.

In his early twenties Kimman began to fire locomotives on the Burlington Railway on runs out of Chicago, and on several occasions served as foreman at various roundhouses. In less than two years he passed the examination and was "set up" as regular locomotive engineer to glory in the feel of the throttle and assume new responsibility.

After the railroad strike in 1888 Mr. Kimman went west, worked a while as a machinist, next served a year as engineer on the Oregon Short Line, and then shipped out of San Francisco as oiler on a coast-plying steamer. Not long, though, and "assistant engineer" was the title which he carried on the steamer's log book. Here he learned the fundamentals of marine engineering that proved valuable in subsequent Naval Reserve duty.

He returned to Chicago in 1890 and soon afterward was appointed chief engineer at the Virginia Hotel, then one of the city's most fashionable hostelries. His white-painted generator units, shining brasswork, and the remarkable neatness of the entire plant made this known as one of the engineering show places in Chicago.

One thing which he inherited in assuming charge of the hotel plant was a pair of thumping hydraulic elevator tanks located at the top of the building. The incessant throbbing of the tanks, which connected through a common line to a pump in the basement, was noticeable throughout the hotel. Many guests complained, and others paid their bills and checked out. The situation was acute. After a careful study of the entire layout, Mr. Kimman placed the two tanks in series with the pump so that one tank stopped the water's impact before it flowed into the second tank. Simple, of course, but the stunt was overwhelmingly successful, and the management's estimation of Mr. Kimman's ability immediately jumped several notches.

In later years as the McCormick Estate made plans for new buildings Kimman was given full hand in the design and the installation as well as the operation of the power and heating plants. And each is conspicuous for intelligent arrangement, easy accessibility to the units, and "apple-pie" orderliness. Keeping everything in the plant uniformly clean is, according to Mr. Kimman's doctrine, the real basis of thrifty power production.

Back in 1898, at the outbreak of the Spanish-American War, Mr. Kimman joined the Naval Reserve, acting as engineer with the rank of lieutenant. He brought a captured Spanish ship, later called the Dorothea, from

the Atlantic Coast to Chicago by way of the St. Lawrence River and the Great Lakes, and during his seven years of duty in this ship he instructed large classes in boiler and engine operation. Many of his engineer students rendered particularly valuable service in the recent World War.

While most of the engineering achievements of Mr. Kimman have been in improving operating conditions and efficiency of the power plants under his supervision, his resourceful mind has pointed the way to several practices which have become quite general in power plants. One of these was the outcome of great difficulty experienced in burning coking coals on chain grate stokers. To solve this problem Mr. Kimman designed a stoker of the chain grate type which broke up the coked fuel bed by causing it to drop a few inches at the point in the furnace where the volatile matter has been driven off. This stoker has been manufactured by the McKenzie Furnace Co. for whom Mr. Kimman has acted in a consulting capacity.

Like many other engineers he has found that it requires more steam used direct from the boiler through reducing valves to heat a building than when the steam is first used for power and then exhausted to the heating radiators. So in one plant he installed a small turbine which is not economical of steam, but which he uses instead of a reducing valve when more steam is required for heating than is supplied by the highly economical poppet valve reciprocating engines of the plant. He thus gets a balance between heat and power load which has proved to be a most economical arrangement during several years of operation.

Years of experience in the operation and management of building power and heating plants and careful study of anthracite records has made of Mr. Kimman an advocate of the block plant as the solution to the mechanical requirements of congested business districts of large cities.

Mr. Kimman believes the young engineer of today has an unequalled opportunity to gain high and remunerative positions. His advice to the young fellow in the boiler or engine-room is: "If you like power plant work well enough to do it even though you *were not paid for it, stick.* But if you are only holding the job because it was the first to turn up and you hesitate to look for another, quit immediately. You may be spoiling a first class bank president in order to make a low grade engineer. If you belong to the first class, do not become discouraged on account of a meager education. For, with an 8-hr. watch you have more time for study, recreation and sleep than ever before. Read the technical journals regularly to keep you mentally alert, and dig into the books that deal with your work. With close study, application and *perseverance,* you can surely find your way to the top."

Recent Progress of Power Development in the World*

How the Power Industry Helps to Solve Problems of After-the-War Europe. By L. W. Alwyn-Schmidt

THE GREAT problem overshadowing everything else of the European power industry is, how to fit a system of modern power supply into the general economic system, so as to make it a real aid in the work of economic reconstruction. It is this problem that lies at the bottom of all changes that are now proposed in Europe and which finally will direct European power development. Europe has suffered heavily during the last six years. How severe its sufferings have been we can hardly realize in this country and we, therefore, have not shown a full understanding of the various problems of the old world. The disorganization of all economic life is not only on the surface, but it is unfortunately very real and is attacking the European countries from their very foundations. Outstanding from all the causes of this perceptible decay is the deterioration of the means of production as represented by human labor. The labor force has not been only decimated by the war, but it has been robbed of its moral backbone. The men who have been fighting in the trenches and those that have spent their days in the feverish toil of the ammunition factories have lost their former responsibility. Having fought and worked unceasingly without any other thought but that of finishing a very undesirable job, they have forgotten their very selves and it is difficult to bring them back to a full realization of their duties during time of peace. Labor has also had a taste of the possession of uncontrolled power and it exerts it now without the restraint necessary in movements depending upon the support of the masses.

While government control and guidance seems to be of no avail, other forces have arisen that may bring the solution. The engineers, the chemists, and the economists have taken hold of the situation. They seem to have realized, first of all, that the old order of things has vanished with the Kaiser and Junkerdom and that a new order has arrived which calls for special remedies. Wonders, therefore, have been accomplished during the last year in respect to industrial organization. Where human power has failed, mechanical power has taken its place and the development once begun will not cease so soon. The chemists have given their aid by increasing the value of the power-giving fuels, while the economists have shown the direction in which power and fuel will have to be applied so to replace the deficiency of the human engine. The engineers have accomplished the rest.

Power supply and coal conservation at the present time is uppermost in the minds of all engineers and the subject is finding the widest consideration in allied as much as in the former enemy countries. Such a general discussion of mutual problems must lead to an understanding about the forms of correction. Just now the following remedies have been suggested:

1. Concentration, wherever possible, of power production.

* This is the first of two articles on this subject by Mr. Alwyn-Schmidt and forms a continuation of his previous articles dealing with similar subjects.

2. Substitution of coal by other forms of generation of power.

3. Conservation of coal properties during combustion.

One or the other of these three points returns in any of the discussions taking place and the effects of the approaching solution of the complete problem can be traced easily all over Europe.

More Power Service Provided in England

In England, the first step for an increase in the general national power supply has been taken by the individual action of the larger cities, which have added in one or the other way to the electrical power supply available in their city limits. Birmingham is an example where 30,000 additional kilowatts are now offered. Nottingham, Sheffield and other cities can be named in the same line. Also the long discussed scheme for the erection of a super-power plant in the Midlands has been furthered considerably. England proper, unfortunately, has few water powers in the southern part of the islands which might be used for electrical generation. The contemplated plant, therefore, must be essentially a coal-fuel plant which naturally means a certain waste of coal by-products. The English gas industry, which is very much interested in the undertaking, therefore, has proposed that the new power station be equipped with large gas engines supplied with gas generated by a large gas plant which then could be equipped with a by-product plant. This arrangement would combine all the advantages of electrical power production and distribution with the saving of the by-products of the coal, that would compensate fully for the somewhat higher cost of the gas-electric plants. Which of the schemes will be finally adopted is still not quite clear. The gas men, however, are putting up a stout fight for their proposal. In the north of England and in Ireland hydroelectric conditions are more favorable. Scotland has a great number of available water-power sites that only need developing to give to its industries all the electrical power that they may require. The Irish situation is now being investigated by a British Government Committee. The Irish water-power situation is very much in the air at present and experts differ about the real value of the Irish water falls for power development. The principal trouble with Ireland just now is that its water powers are always disarmed in a political and not in an engineering problem. There are several Irish counties that are really well supplied and others where a good supply could be obtained if somebody would take interest in them and develop the available sources. Ireland in many respects is better qualified for the development of an electro-chemical industry than is Norway. It has the special advantage that it is part of the body of the British Empire, which would give to an Irish industry of this character an enormous market, quite apart from the great benefits to be obtained by Ireland itself from the use of its hydroelectric powers. Such a development of national power would certainly relieve the industries of the country from the necessity of importing coal in large quantities and would aid, in consequence, in the upbuilding of a good-sized Irish industry.

Tidal Water Power Seriously Discussed

The most interesting of the projects under discussion in England, no doubt, is the renewed attention that is given to the possibilities of using the tidal powers of the island. England has a few exceptionally good sites for this purpose. A group of engineers has interested itself in the subject and contemplates the construction of tidal water plants on several coast places in England. It is estimated that in one case alone 120,000 hp. might be obtained. Naturally, much of the whole discussion is still carried on upon a purely theoretical basis. In fact, the whole problem of using the tides for power development is already pretty old. It is claimed that a wall can be constructed sufficiently high to permit the insertion of turbines, which could be used for the generation of the power, both when the sea enters the basin and when it is leaving. The main difficulty seems still to be how to make these walls sufficiently strong to withstand the undermining effects of the sea.

England, however, does not stand alone in these efforts. France also, has given the problem serious consideration and a commission of engineers was appointed to report on the question. The report seems to have been generally in favor of further experiments and it is now proposed to carry out practical investigations at several places in Brittany, which, if successful, may be followed by the construction of a complete tidal water plant.

France Busy on Large Developments

But France does not propose to wait upon the completion of these experiments for the solution of its various and very pressing power problems. France has suffered heavily in man-power during the war and only the most exhaustive replacement by machine power can save it from debacle. So a beginning has been made to complete the large scheme of hydroelectric development already started before the war. According to French investigations, France has water powers available in the following districts: Northern Alps, 2,000,000 hp.; Southern Alps, 2,600,000 hp.; northern central mountains, 1,900,000 hp.; Pyrenees, 2,800,000 hp. This is a total of 9,300,000 hp., of which only 800,000 hp. was developed by the beginning of the war. Since then, a great deal has changed in France. The French coal mines have been destroyed and the English coal supplies are not flowing as regularly as they used to. The coal that France is to get from Germany will be used mostly for the purposes of her iron industry and France, therefore, requires other power sources. It has started with the electrification of all those railroads that can be worked by electricity, but progress is now very much hampered by lack of capital. It is expected that American capital may be induced to take an interest in French hydroelectric development. This development is to run along lines which have now been settled and a start will be made as soon as can be with the work upon the various projects. The Rhone district will probably be the first, where 750,000 hp. equivalent to a coal conservation of 5,000,000 tons can be obtained. The full cost of this project will amount to well above 2,500,000,000 francs, but the expenditure appears to be small in comparison to the great benefits that may come to France by the execution of this development alone. The principal advantage seems to be that the whole region can be made independent from coal supplies from the north. This coal then will be available for other districts where little

water power is available. Second in importance and in order of development most likely will be the Pyrenees region where Bordeaux and other cities offer an excellent field for the sale of electric current. The whole of the South of France will form a large net of interlocking power stations, part of which will be located at the Rhone and the rest on the northern slope of the Pyrenees. This part of France in due course must become a very important market for electric power machinery. France, of course, is able to handle part of its needs in this respect itself, but it is hardly to be expected that it will expand its electrical industry quickly enough so as to take care of the whole of the machine equipment of this development, which has to be executed very rapidly to be of any real use for France during the reconstruction period. It has been suggested, therefore, that America not only supply part of the capital for the enterprise, but also take a hand in the construction of the required machinery, which would mean that the American monetary contribution would be spent in the United States for machinery. The proposal certainly seems attractive and French engineers hope that it will find acceptance on our side

It is a peculiar fact, but will not astonish those who know European conditions, that the future of the French power industry is closely connected with a similar development in Germany. France has just now taken over a large slice of the former German empire, which includes a large manufacturing district, rich iron mines, and also part of the German resources of coal. France also has become a party to the Rhine commission and in doing so has gained a certain control upon the development of the German water powers on the tributaries of the Rhine, which in this manner become dependent upon French action. For a while, it seemed as if France was rather disinclined to give to Germany a free hand in the development of these of her resources under the pretext that such a step would impair the French rights upon the navigation of the Rhine. Now it seems, however, that common sense gains the upper hand in France and elsewhere, in the conduct of European international affairs and that France has realized the importance of the rest of Germany for her new Alsatian possessions. The modern Alsace-Lorraine is closely interconnected industrially with Germany, and the one seems unable to exist prosperously without the other. So the two countries will be forced to a certain amount of economic cooperation that may finally lead to a very close understanding. Steps have been taken already by France for the opening of banking centers in the more important German cities in the Rhineland and elsewhere and the result can only be a close participation of France in German economic affairs, a development that at the present moment seems rather to be liked by the Germans themselves.

Germany Prepares Way for National Monopolies

German industrial enterprises, financed by French money, therefore, will require the supply of German electrical energy and it must be to the interest of France that this power supply should be up to date. Hence the change of attitude in France with regard to the German electrical industry. This development, however, is somewhat hindered by the avowed intention of the German government, to make all electrical power generation a state monopoly. Germany will need the money to reconstruct its economic life and, therefore, will have to use the state monopoly as an additional source of income. The nationalization of the electrical power production, consequently, will soon be followed by the nationalization of the local mines and other prime sources of national wealth. The interest of the allied powers in all matters connected with the production of electrical energy in Germany is further illustrated by the case of the free-city of Danzig. Danzig is still only partly supplied with electric power and the interests of the district require the urgent construction of power plants. It is proposed to secure part of the supply by water.

Italy Pays Subsidies to New Hydroelectric Plants

The German power problem is especially pressing just now, owing to the lack of coal production. Normally Germany can go along very well with its coal supply, but since the signing of the armistice, the coal mines have fallen behind seriously with their deliveries. Conditions in Germany differ in this respect from those in Italy, where the provision of electrical energy is a matter of absolute necessity without which Italy cannot hope to recover from the results of the war. To hasten construction, the Italian Government has taken to the means of subsidies. These are to be paid only to hydroelectric plants and a decree has been issued which grants to enterprises which either have been started after the first of January, 1919, or 4 yr. before that date and are still under construction, an annual payment of 40 lire for each nominal horsepower delivered.

This subsidy is to be paid for the period of 15 yr. Freedom of certain taxes has also been granted. To encourage the construction of transmission lines, special subsidies also will be given for these and premiums are offered to those who employ electricity in agricultural and irrigation work. Hydroelectric construction has proven rather expensive in Italy. At an average, $100 per horsepower is estimated as the cost of the development in the larger undertakings. In a country like Italy, however, where little coal is obtainable and which is dependent, therefore, practically entirely upon foreign fuel, the cost of the initial installation of a hydroelectric station cannot play any considerable part.

Part of the Italian hydroelectric development will be carried out probably in co-operation with Switzerland. The Swiss Government has worked very effectively on the electrification of its railroads and as the result at least one of the undertakings is nearing completion. This concerns the international section of the St. Gotthard railroad, one of the finest engineering feats of the world. The line lies partly in Swiss and partly in Italian territory, and Italy will have to take a hand in the supply of the power when once the whole project is completed.

European power development has made enormous strides ahead during the last twelve months even under the severe handicap of the reconstruction period. Much has been accomplished that would have been thought impossible only a few years ago. The whole problem of power production and distribution having once come into motion, it is to be expected that it will not rest again until completed.

The Use of Superheated Steam in Power Plants

A Brief Discussion of the Advantages and Factors to Be Considered in Its Use

THE FACT that superheaters have been installed, almost without exception, in the largest and most economical power plants throughout the world is probably the most conclusive evidence of the advantages obtained from the use of superheated steam. Practically all of the modern central turbo-generator stations and large isolated reciprocating engine plants are designed for the use of superheated steam. While there are cases, of course, where the installation of superheaters would be in no way advisable, such cases are rare, and are the exception rather than the rule. It is true that it may prove impractical in many cases to use high degrees of superheat in old plants, but it is equally true that there are few plants which cannot be operated entirely satisfactorily with 100 to 125 deg. superheat using present equipment. In all instances, however, when the installation of a superheater is contemplated, the problem must be carefully studied and considered in all its phases. The actual saving possible by the use of superheated steam must be balanced against such factors as initial cost, upkeep, nature of service of plant in question, design of prime movers, consideration of pipe and fittings, etc.

Without considering other factors, the principal purpose of superheating steam is to save fuel and the importance of conserving fuel in these days of tremendously increased consumption and world-wide scarcity is too well known to require discussion.

The correct application of superheated steam will effect greater economies in the operation of power plants, per dollar invested, than any other single improvement in power plant design. Aside from the gain in the prime mover, there is the possible added efficiency in the boiler.

There is no valid reason in theory, or practice, why new steam power plants, no matter how small, should be built today without the installation of suitable steam superheaters. It is difficult to understand why the present day turbine plants with units of 20,000 to 60,000 kw. capacity are utilizing high superheat; while the smaller units, which are most benefited by high superheat, are operating with saturated steam or a low degree of superheat. In general, the smaller the steam motor the more is the gain effected by superheating. In the majority of moderately superheated steam installations, the ultimate gain has been substantial. The advantages of the superheater are numerous and well known, and certainly there is nothing in the design of boilers, engines or auxiliary equipment that presents difficulties.

Economy of Superheat

Superheaters increase the economy of a plant in four ways: (1) by increasing boiler efficiency, (2) by increasing the capacity of the plant, (3) by reduction in condensation losses, and (4) by reducing steam consumption of prime mover.

It is too often assumed that there is only a saving in the operation of the prime movers when considering the savings possible by the use of superheated steam. This misconception is due to the fact that fuel consumption of the boiler is only considered in connection with a definite weight of steam. It must be understood, that where a definite weight of steam is to be superheated, an additional amount of fuel must be burned. With a properly designed superheater integral with the boiler, the overall efficiency of boiler and superheater is usually somewhat higher than if saturated steam alone were generated, so that the added amount of fuel is less than the heat gained by the steam. By the addition of the superheating surface, more heat is absorbed and the temperature of the exit gases will be lowered. Such a lowering of uptake gas temperature is the ultimate indication of added efficiency.

A properly designed superheater installed in a boiler relieves the boiler heating surface of a portion of the work required in the generation of a certain number of heat units as compared to the same number of heat units delivered in saturated steam. This results either in a

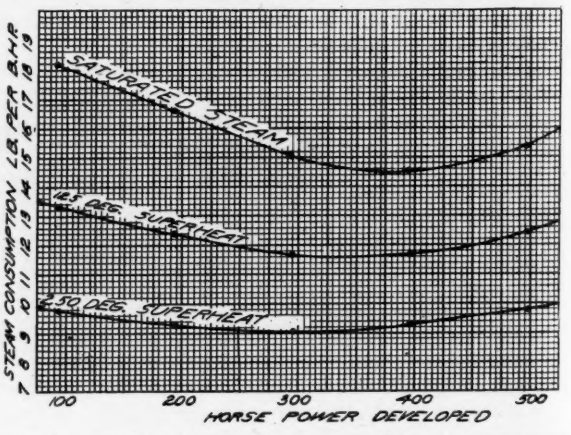


FIG. 1. STEAM CONSUMPTION OF A 250-HP. COMPOUND-CONDENSING ENGINE AT DIFFERENT LOADS

reduction in the capacity at which it is necessary to operate the boiler itself in developing a definite number of boiler horsepower, or it enables an increased number of horsepower to be developed by the same number of boilers with the boiler heating surface doing the same amount of work as if no superheaters were installed.

In large steel plants, local conditions may force the prime movers to be operated at comparatively great distances from the boilers. The long pipe lines carrying the steam are often run out of doors where they are exposed to all kinds of weather. Naturally such conditions have a marked effect on the quality of the steam when it reaches the point where it is to be used.

Superheated steam may here be used to advantage because of the fact that by its use condensation is prevented in these long steam lines. No moisture is carried over from the superheater, and since the thermal conductivity of superheated steam is much lower than that of saturated steam, heat is not transmitted so rapidly to the walls of the pipe and condensation is prevented. In this connection, superheating is advantageous not only

from an economical standpoint but also because it eliminates water hammer and its attendant dangers.

Long steam lines in existing power plants now carrying saturated steam can readily be made to carry superheated steam without any change whatever, with consequent increase in available heat and amount of steam delivered. In the generation of saturated steam about nine-tenths of the heat absorbed by water in evaporating it and in raising the steam pressure is latent heat. Therefore, when condensation occurs in pipe lines the latent heat is liberated and nine-tenths of the heat is lost. If the condensate is not returned to the boilers all the heat is lost. In order that all of the steam may be transmitted to its destination without condensation losses, it is absolutely essential that its temperature first be raised to a suitable degree by means of a superheater.

There are limits, however, to the extent that this rule may be followed. In extreme conditions where the lines are exceedingly long, instead of a saving there may be an actual loss in the use of superheated steam. An analysis of an 8-in. line, 3000 ft. long, with a 1-in. magnesia covering to supply 1000 hp. at the end, shows an actual net loss of 0.7 per cent with superheat. The physical significance of this result is that the line is of such length and condition that all the superheat is lost in transit. Thus, while no actual condensation takes place in the line, the heat loss is greater than the loss with saturated steam because of the higher average temperature within the pipe. The pressure loss is also greater, and, since the prime mover will be supplied with saturated steam in both cases and lower pressure in the one case, its potential efficiency and steam economy will be less. These extreme conditions, however, are rare and in most cases the use of superheated steam in long well insulated pipe lines will effect great economies.

Steam turbines are particularly adapted to the use of highly superheated steam as there are no rubbing surfaces to become bound by expansion of materials. Furthermore, experience has unquestionably shown that the use of superheated steam with turbines leads to an appreciable gain in economy. This fact is so well established that engineering practice does not countenance the installation of turbines for use with saturated steam. All turbine plants of any size are now equipped with superheaters and some modern plants are using 250 deg. According to D. D. Pendleton the most economical steam prime movers today are utilizing steam of 300 deg. superheat or more and produce a brake horsepower for 8 lb. of steam, and on less than 1 lb. of coal.

The water rate of a large economical steam turbine with superheated steam is reduced about one per cent for every 12 deg. of superheat up to 200 deg. Of this gain only about 40 per cent is to be expected from the increased thermal efficiency; however, the effect of superheat on the turbine is greatly to reduce the friction of the passage of steam through the blading and the remaining 60 per cent of the saving is effected by this means.

The use of saturated steam in turbines, even when it is dry, upon entering the first stage, will, in expanding through the successive stages, cause enough condensation to give trouble through the presence of water in the low pressure stages. If superheated steam is used, the amount of water in the low pressure stages will be reduced to a point where no trouble is caused. It is stated on good authority that one per cent of moisture in the steam will reduce the economy approximately two per cent.

The erosion of the turbine blades by the water carried in the steam is another serious factor which the use of superheated steam renders negligible. This is a most important argument for the use of superheated steam in turbines and is brought home by the fact that just recently, a plant had two 6000-kw. machines rebladed and the cylinder surfaces refinished at a cost of about 40 per cent of the original cost of the turbines in 1912. This was after 7 yr. of use with saturated steam. If superheated steam had been used, it is probable that this reblading would not have been necessary.

As stated before, in a turbine the effect of superheat is more mechanical than thermal and the benefit comes chiefly from the elimination of moisture and consequently reduced internal friction. There is, however, also an important economical gain as shown by a test of a 12,500-kw. turbine showing 15.7 lb. of steam per

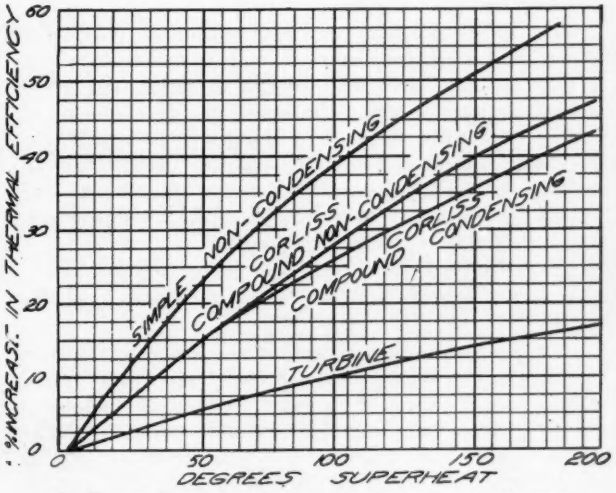


FIG. 2. EFFECT ON THERMAL EFFICIENCY OF VARIOUS DEGREES OF SUPERHEAT

kilowatt with dry saturated steam, and 13.75 lb. with 100 deg. superheat—a saving of 12.5 per cent.

The benefit obtained by the use of superheat in a reciprocator is even greater than in the case of a turbine. A considerable saving is accomplished by the elimination of condensation in the cylinders, and this elimination is not at all to be compared with that of piping, regardless of whether the engine is insulated or not.

With the initial saturated steam coming in contact with the cylinder walls and steam ports which were just swept by exhaust steam, and are, therefore, comparatively cool and wet, condensation occurs because the steam readily gives up, without much resistance, a part of its heat; while with superheated steam on account of its higher resistance to heat exchange, these losses are considerably reduced.

The amount of saving will depend upon the amount of condensation that would take place if saturated steam were used. The greater this amount of condensation the greater will be the economy effected by the use of superheat. If the steam be superheated sufficiently to allow

of a reduction in temperature equivalent to the amount of heat that must be imparted to the cylinder walls and still remain superheated, it is clear that the condensation in the cylinder is avoided. The superheated steam furthermore has a greater specific volume than saturated steam of the same pressure which taken together with the elimination of all condensation losses, effects a substantial saving in the steam consumption and in the fuel consumption when compared with saturated steam operation under the same conditions. The effects on the thermal efficiency of various types of prime movers is shown graphically in Fig. 2.

Effects on Piping and Fittings

The question of piping and of the proper fittings to be used with superheated steam is one which is frequently discussed. It is an undoubted fact that while in some instances superheated steam has caused deterioration of cast-iron fittings, in others, such fittings have been used with 150 deg. superheat without difficulty. Undoubtedly, the quality of the cast iron used for the fittings has large bearing on the life of such fittings for this service.

The difficulties that have been encountered with the use of cast iron are distortion and an increase in size of the fittings, with an eventual deterioration great enough to lead to serious breakage, the development of cracks, and, when flanges are drawn up too tightly, the breaking of a flange from the body of the fitting. In certain instances, the latter difficulty is undoubtedly due to the form of flange in which the strain of the connecting bolts tended to distort the metal.

The tendency seems to be to use cast steel in superheated steam work, and experience has shown that this metal is suitable for the service.

In regard to piping, it must be remembered that due to the higher temperatures present with superheated steam, proper care must be taken to allow for expansion in order that there may be no undue strains. If this precaution is observed, there will be no greater operating difficulties with moderate degrees of superheat not exceeding 200 deg. than with saturated steam.

It is no doubt commonly known that with superheated steam a greater velocity in the piping can be allowed than with saturated steam and that velocities of 10,000 ft. are commonly used. Due to this greater velocity, a smaller pipe may be used, thus considerably reducing the radiation losses.

Types of Superheaters

Superheaters may broadly be divided into two classes: those which are independent of the boiler and those which are installed within the boiler setting. The independently-fired superheater is very little used and practice seems to favor placing the superheater within the boiler setting. The radiation losses are thus not increased over those of the boiler itself, and if properly placed will offer no undue resistance to the passage of the hot gases. The efficiency of a superheater integral with the boiler is therefore higher than if independently fired. There are, however, many places and conditions where its use is advisable. In plants where waste gases of high temperature are available, it is the proper type to use. With the advent of the compound turbine, it is quite possible that the independently-fired superheater will be used to resuperheat the steam between the high and low pressure units. Furthermore, it must not be thought that because a superheater is located in the path of the flue gases it does not require extra fuel to heat it. The higher the temperature to which the steam is superheated the more fuel will be required. With a properly designed superheater, where the combined efficiency of the boiler and superheater will be at least as high as the boiler alone, the approximate increase in coal consumption for producing a given weight of steam will be as follows:

Superheat Degrees	Added Fuel Per cent
25	1.59
50	3.07
75	4.38
100	5.69
150	8.19
200	10.58

The correct application of superheaters to the individual conditions in a specific power plant is the one means of positively improving the operation of the plant at least in one, and probably in all parts of the plant where steam is used.

Elevator Accident

While working in the elevator pit at the Carter-Rice Paper Co. in Denver, Colo., H. M. Shay, a mechanic, was struck by the descending car, his back was badly wrenched and he was otherwise internally injured. Shay was given hurried medical attention and it is thought his injuries will not prove fatal.

This is the second elevator pit accident at Denver within the month of May, the former proving fatal, and no one could say how it happened; but we have the full facts in the present case, which seem to indicate that proper precautions were not taken.

While it is not necessary to shut down every elevator for repairs, yet whenever there is danger lurking it is better to cut off the current for a short time, even though there is some discommoding, rather than disobey the law of Safety First. J. B. Dillon.

To prove multiplication without brain fag, try this:

246=12=3
135= 9

1230 27=9
738
246

33210= 9

After working a problem, add the digits of the multiplicand. In this case, they come to 12. In all such instances, continue to add the digits until the result is one figure; in this instance, 12 reduces to 3. In like manner, add the digits of the multiplier. Then multiply these results. In this example, we have 27, which, reduced to one figure, gives us 9. If the digits of the result, when added together and reduced to one figure, are likewise 9, the problem is correct. If it does not correspond, an error has been made somewhere.

Linking the Great Lakes to the Atlantic

A Discussion of the Proposed St. Lawrence Waterway with the Power Aspects of the Problem

PROBABLY NO factor in establishing the economic stability of the nation is of greater importance to the American public today, than that of the transportation and distribution of our multiple commodities. The nation must have adequate transportation facilities if we are to reap the full benefit of our tremendous resources. Today, tens of thousands of tons of food and other necessaries are piled up in the West and Northwest with no chance to move them because of the lack of cars and the demoralized condition of our railroads. The eastern and European markets have been calling for these supplies for months and because of their scarcity, consumers have been paying excessive prices. It is inevitable, therefore, that we find other means of distribution so that the tide of foreign and domestic commerce may be brought to a state of equilibrium.

In view of these facts, the importance of the hearings of the International Joint Waterways Commission, now being held in various cities throughout the country, can hardly be overestimated. The idea of making possible the direct passage of ocean-going steamships from the Great Lakes basin, to the cities of Europe, is old—indeed, in an academic way, it was thought out and discussed much more than a century ago, and three-fourths of a century ago, a series of canals were built around various rapids of the St. Lawrence River and across the Niagara Peninsula. These, while adequate for their own time, were soon too small and even the subsequent improvements were soon outgrown by the rapid growth in the size of ships. Today, the question of providing a navigable passage between the Great Lakes and the Atlantic Ocean looms up stronger than ever before, and in a large sense, the welfare of all of us depends upon such a project being carried out.

The Heart of Our Country

The economic significance of the states bordering upon or tributary to the Great Lakes is seldom realized by the people of other divisions of the country. Horace C. Gardner, who is president of the Great Lakes-St. Lawrence Tidewater Association, has furnished us with the map shown in Fig. 1. Let us turn to this map and follow the heavy black line beginning on the boundary between Maine and New Hampshire to the dotted line beginning at the lower central part of Colorado, and then follow this dotted line to the Canadian border.

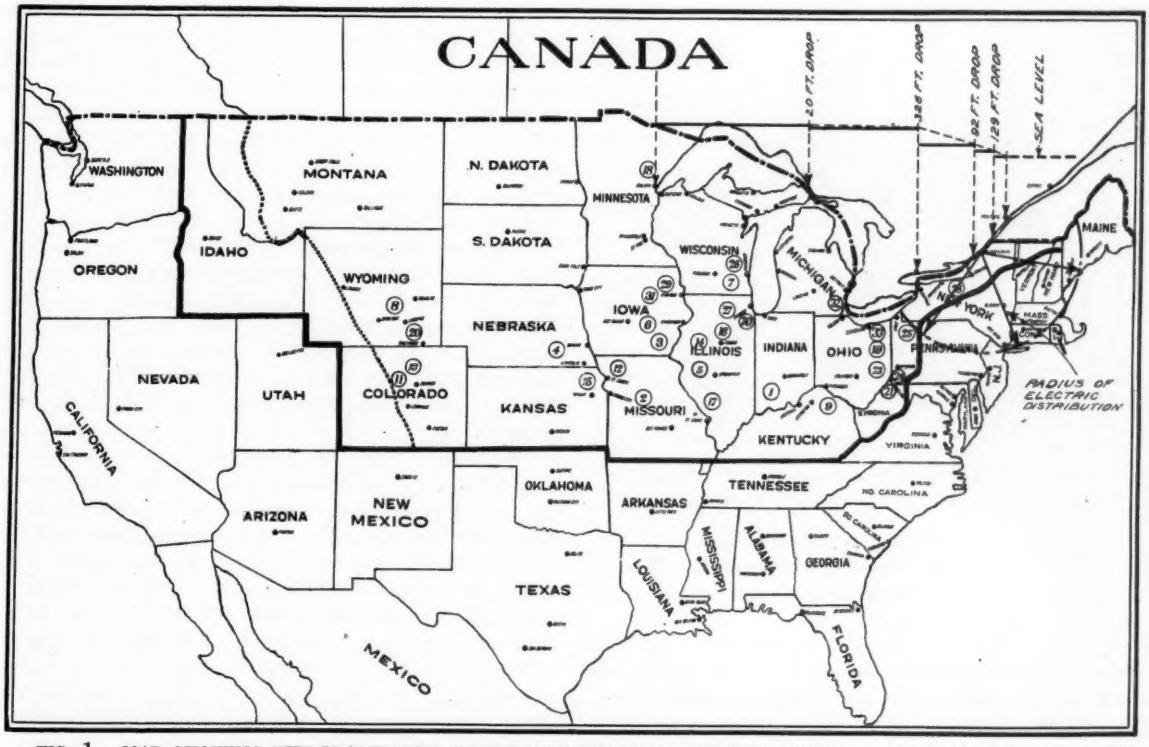


FIG. 1. MAP SHOWING THE PRODUCTION CENTERS, ELEVATIONS AFFECTING THE ST. LAWRENCE RIVER PROJECT, AND THE RADIUS OF POWER DISTRIBUTION

The territory included between the line just described and the Canadian border, is correctly called the heart of our country. It embraces something more than a third of our territory with more than a third of the population and more than a third of the wealth. Potentially, this heart of the country is probably more than half of the whole country.

According to the latest figures available, its present productivity may be stated as follows, in terms of percentages of the total: Corn production, 65 per cent;

apples, 21 per cent; cattle, over 50 per cent; hogs, 57 per cent; butter, 54 per cent; eggs, 54 per cent; coal mined, 36 per cent; copper, 39 per cent; lead, 46 per cent; wheat production, 74 per cent; flax production, practically 100 per cent; beet sugar, 53 per cent; horses, 60 per cent; wool, 47 per cent; cheese, 57 per cent; iron ore, 85 per cent; coal reserves, 72 per cent; zinc, 74 per cent.

On this map will be found also various centers shown as a circle with numbers in them. These are the centers of production of various products, comprising practically all of the fundamental necessities of life. The method used in establishing these centers with respect to all except the center of population, is to determine a north and south line, east and west of which half of a given product is produced and then determine an east and west line, north and south of which half is produced. The crossing then, of these median lines determines the center.

In considering the significance of the location of such centers, we must keep in mind the normal direction of freight movement, which is always from the region of

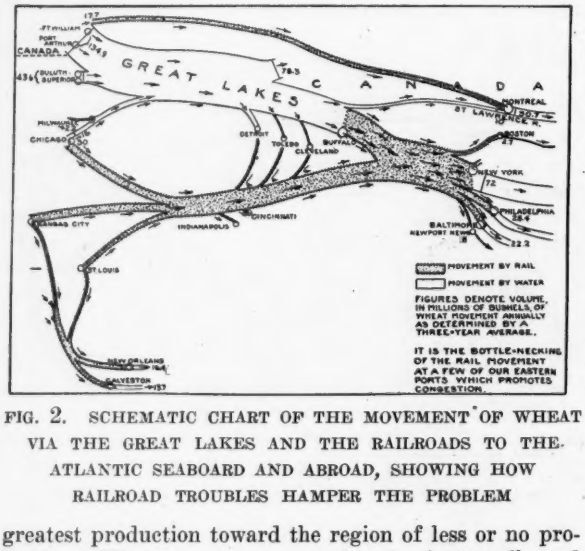


FIG. 2. SCHEMATIC CHART OF THE MOVEMENT OF WHEAT VIA THE GREAT LAKES AND THE RAILROADS TO THE ATLANTIC SEABOARD AND ABROAD, SHOWING HOW RAILROAD TROUBLES HAMPER THE PROBLEM

greatest production toward the region of less or no production. We have a movement of grain, food stuffs, and feed always toward the east, while manufactured products largely move toward the west.

By comparing the numbers on the map with the numbers given below, the location of the production centers may be found. 1, center of population, Indiana; 2, farm acreage, central Missouri; 3, farm values, S. E. Iowa; 4, wheat, S. E. Nebraska; 5, corn, Illinois; 6, oats, S. E. Iowa; 7, potatoes, S. E. Wisconsin; 8, wool, Wyoming; 9, tobacco, N. E. Kentucky; 11, beet sugar, W. Colorado; 12 horses, N. W. Missouri; 13, sheep, N. Colorado; 14, milch cows, Illinois; 15, other cattle, E. Kansas; 16, butter, N. Illinois; 17, swine, S. W. Illinois; 18, iron ore, N. E. Minnesota; 19, pig iron, E. Ohio; 20, bituminous coal reserves, S. E. Wyoming; 21, bituminous coal production, West Virginia; 23, primary horsepower used in manufacture, E. Ohio; 24, persons engaged in manufacture, S. W. Pennsylvania; 25, value added by manufacture, N. W. Pennsylvania; 26, cheese, S. E. Wisconsin; 28, shoes, near Rochester, N. Y.; 29, eggs, N. E. Iowa; 30, men's clothing, near Chicago; 31, slaughtering and meat packing, N. E. Iowa; 32, automobiles, near Detroit, Mich.; 33, rubber goods, near Akron, Ohio.

And yet with all this potential and actual wealth we are sufferers and have been for many weeks and months. Our business and all of our activities are hampered for lack of transportation.

A study of figures showing our exportations of grain and heavy freight shows that if we could load vessels directly at the ports of the Great Lakes and ship thence without breaking bulk to European ports, practically all of the excessive peak load could be absorbed and incidentally a tremendous car mileage could be avoided as well. The diagram (Fig. 2) taken from Robert G. Skerrett's article in the Scientific American shows the congestion caused by the "bottle neck" effect of our eastern railroads, in the transportation of our wheat.

The New Project

The real remedy for our freight blockade would seem to be, to open the Great Lakes so that ocean-going vessels may freely enter and make use of various ports, at many of which our railway systems already center.

The cost of this splendid project would be trifling in comparison with the immediate and prospective benefits to be realized. The present scheme for deepening the St. Lawrence would be a joint Canadian and American effort. Canada has already taken into her own hands the construction of a new Welland Canal across the Niagara Peninsula, the depth through the earth sections to be 25 ft. and the mitre sills of the locks 30 ft. The expected cost was $50,000,000 and the work was well under way when, in the summer of 1914, Canada found herself at war. The work was courageously continued for about a year, when for financial reasons and lack of manpower it was stopped. However, work has now been resumed and it is expected this canal will be finished in 3 yr. It will be adequate for the typical ocean freighter of today.

What about the St. Lawrence rapids? How can they be avoided or what may be done to enable vessels to come up and use the new Welland Canal? It is proposed, by constructing a series of great dams, to drown out the rapids, thus converting them into lakes. Locks would be put in to enable vessels of any size desired to pass. This method will possess the further great advantage of developing a tremendous amount of electrical power.

Advantages in Favor of the St. Lawrence

To the American mind, of course, very naturally comes: Why the St. Lawrence? Why not an all-American route up the Hudson and into Lake Ontario? There are several very good reasons for favoring the St. Lawrence.

In the first place, nature shaped the course of the St. Lawrence so that it runs from the heart of the North American continent directly toward the principal ports of Europe. The accompanying map, Fig. 3, shows, as well as a flat surface can show, this relationship not only of the St. Lawrence but of our entire Atlantic coast to the Atlantic coast of Europe.

Rochester is nearer to Liverpool than is New York. Buffalo is but a few miles farther. From all our ports on Lakes Ontario and Erie, it is 250 mi. farther to Liver-

pool, London, and northern French ports and all North Sea ports via New York than via the St. Lawrence. It is evident therefore, that the distance is in favor of the St. Lawrence route.

Possibilities Regarding Power Development

Another tremendous advantage is the power. The normal mean flow of the St. Lawrence at its outlet from Lake Ontario is 240,000 sec.-ft. There is between the head of the rapids near Ogdensburg, N. Y., and the foot of the lowest rapid just at the City of Montreal, a total fall of 221 ft.

This is divided into several rapids, and in the river proper above Montreal there are two considerable lakes—Lake St. Francis, about 30 mi. long, and Lake St. Louis, about 16 mi. Of course, these lakes would not be interfered with. The levels will probably be raised somewhat by the series of dams already spoken of. The reservoir capacity of these two lakes together with the whole body of Lake Ontario would allow the river flow to be almost absolutely controlled, and power production could be timed to meet the demand. In fact, there is now under consideration by the two governments the question of controlling not only the flow of the St. Lawrence but of the Niagara River as well, the purpose being to compensate for the diversion of water through the Chicago Drainage Channel. The Sanitary District Trustees have offered to meet the cost, which is comparatively small. The question of the control of the flow of the St. Lawrence will no doubt be merged with the improvement of the river for navigation and power. Deducting from the 240,000 second feet, say, 10,000 ft. for diversion through our Drainage Channel, and reckoning on the remaining 230,000 second feet at full head, the power development on the 100 per cent basis would amount to 5,750,000 hp.

If 70 per cent of the power can be realized, the development would amount to over 4,000,000 hp. The first 113 mi. of the river from its outlet from Lake Ontario is international—that is, it constitutes the boundary between the two countries. The fall in this section, confined to about 42 mi. is 92 ft.; the power possibilities of this section on the same basis, would be practically 1 2/3 million hp. Normally one-half of this would be Canadian and one-half United States. It would seem, therefore, that the minimum power that may be developed from the St. Lawrence and distributed through northern New York and New England would be 800,000 hp. It is not unlikely, however, that in the final bargaining between the two countries, the United States may assume some of the expense of improvement below the international section of the river, and in return receive more power. We would have the demand, or at any rate within a short period would grow to have, and the need in Canada is relatively much less.

The possibilities of this enormous increment of power and its distribution for railroad and other industrial purposes throughout New York and New England can be appreciated. All of the New York Central Railroad system north and west of Albany might be electrified. If the power available proved more than adequate, it could be transmitted to greater distances, even as far as New York. This source of power could be made part of the proposed super-power zone, advocated in the eastern industrial district.

Cost

In a preliminary way the Canadian government recently estimated the cost of the St. Lawrence improvement for the international section, including preparation for power installation, but not machinery and equipment for power development, at $60,000,000 and for the all-Canadian section of the river $50,000,000. The total, $110,000,000, may upon full examination prove too small. Let us suppose that $200,000,000 may be necessary. Suppose, also, that we get one-half of the power, 2,000,000 hp. Put a low rental price on this—any price you see fit. It is evident that we will reap a great profit, and in a very few years will amortize the entire cost.

And then there is the more fundamental question still of the conservation. Taking a horsepower-year equivalent to 18 or 20 tons, which is conservative, the total coal saved per year would be 40,000,000 tons.

We can also save with this, the additional tonnage necessary to transport it from the coal fields, an element variously reckoned at from 20 to 40 per cent of the primary coal tonnage. Considered internationally, the

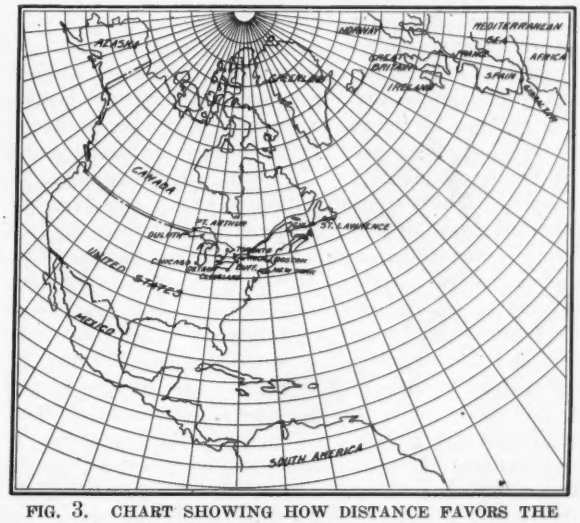


FIG. 3. CHART SHOWING HOW DISTANCE FAVORS THE ST. LAWRENCE

saving on the full 4,000,000 hp. would amount to 100,000,000 tons of coal a year. Furthermore, how many miners are required to mine, say, 50,000,000 tons of coal, and how many mine laborers and others in and about the mine? How many railway employes would be necessary to transport the coal?

The problem has many ramifications, but look in whatever direction you may, you see the possibility of a substantial saving, and in the aggregate the improvement of the St. Lawrence will be amply justified if considered as a conservation measure only.

If we continue shipping abroad, say 300,000,000 bu. of wheat produced in our middle west, it is estimated that we can save from 5 to 6 cents per bushel. Here would be $15,000,000 to $18,000,000 per annum. We have other products to ship both in and out. No one can figure what the total saving may be, but that it would be enormous and many times sufficient to justify the expense is undoubted.

Deaeration of Feed Water Discussed*

CHEMICAL AS WELL AS MECHANICAL METHOD PROVES SUCCESSFUL IN CONTROLLING CORROSION. BY F. N. SPELLER

THE METHOD of mechanical deaeration described by Mr. McDermet (June 1 issue) affords another means whereby the gases may be removed from water, and illustrates again that the practical solution of the corrosion problem is mainly a question of special engineering design. Having been engaged in investigations on the cause and prevention of corrosion for the past 15 yr., it is gratifying to see the growing interest manifested by engineers in this important matter. At temperature below 180 deg. F., our experiments have shown that the last ½ c.c. per litre of oxygen is much more difficult to remove by mechanical means, while above 180 deg. F. equilibrium can easily be obtained when the temperature approximates the boiling point for the prevailing pressure. Perhaps the author can furnish some data as to the minimum amount of superheating required to remove all the gases at temperatures down to 130 deg. F.

The oxygen contents (which is closely proportional to dissolved air) vary from 5 to 10 c.c. per litre in natural water according to seasonal temperature. As it is simple enough to remove most of the gases without any special apparatus other than a well vented heater, it is perhaps better not to consider percentage removal of gases but rather as to how much remains after leaving the heater and how best can this residual oxygen be removed. The variation in reduction of dissolved air reported from 10 to 70 per cent at 212 deg. F., if I interpret these figures correctly, indicates the use of an undersized open heater. It would seem more desirable to plan to remove dissolved gases as far as possible in the heater. An open heater operating at National Tube Co., McKeesport, Pa., at a temperature of 170 deg. F., left a daily average of 2.55 c.c. per litre of free oxygen in the feed water, the theoretical minimum for these conditions being 2.35 c.c. per litre. Another series of tests made at another plant with an open heater temperature of 204 deg. F. gave us 0.75 c.c. residual oxygen, the theoretical minimum under these conditions being 0.50 c.c. per litre. A test on a large open heater at the Philadelphia Electric Co. reported to me by N. E. Funk, gave 0.70 c.c. per litre in feed water leaving heater at 209 deg. F. with some corrosion in economizer tubes, but much less than before when the heater was operated at 148 deg. F.; feed water after heating in this case carries 2.06 c.c. per litre of free oxygen. We have shown, however, that it is possible to approach quite closely to the theoretical minimum oxygen in an open heater by a larger area of baffles or by spraying the water.

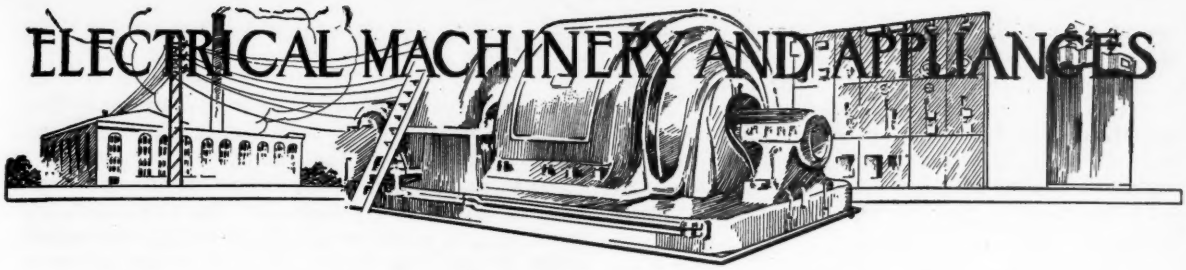
The method of collection of sample is not described and may have a bearing on the heater variations to which Mr. McDermet refers. In taking samples of hot water under pressure for oxygen determination, we draw the sample slowly while under pressure through a copper or tin coil immersed in ice water so that when drawn into sample bottle, the temperature of the water is about normal. This insures retention in solution of all gases and if the sample tube extends to the bottom of the bottle, a sample can be collected in a minute or two without agitation and without reabsorption of air.

The amount of residual oxygen which will cause serious corrosion in a given time varies with the temperature at which the water is to be used. It has been demonstrated experimentally by the work done by Dr. W. H. Walker of the Massachusetts Institute of Technology and ourselves that corrosion of piping is closely proportional to the free oxygen in solution. Several years experimental work on mechanical and chemical deaeration has been done at the Massachusetts Institute of Technology and National Tube Co. Research Laboratories in co-operation and several plants have been put into service to test out these principles in hot water supply systems for building and in central heating stations and power plants to develop the best type of apparatus for such service. The experience indicates that feed water used with steel economizers should carry less than 0.20 c.c. per litre. The above tests therefore indicate that open heaters as usually operated will not reduce the oxygen low enough to stop corrosion. The residual oxygen in feed water after passing through a properly vented open heater, may be reduced below the danger point by further mechanical deaeration such as by passing the water from heaters over baffles at about the boiling point in a separate chamber at lower pressure (no condenser required) or by injecting the superheated water into a low pressure chamber with a condenser in series as described by Mr. McDermet; or the residual oxygen passing through the heater may be quickly and completely removed by chemical treatment or combination of both systems as is both suitable and convenient. We have had a process for removing oxygen by the latter principle in continuous use for nearly 5 yr. This is based on passing the heated water under pressure through a large mass of expanded steel scrap, which I have termed "deactivating" the water in distinction to mechanical deaeration. In this way, the last trace of oxygen may be removed within a wide range of temperature and pressure.

Mechanical means for removing free oxygen from water requires careful adjustment and control of temperature and pressure whereas chemical means such as the use of suitable kind of steel scrap, will "fix" the oxygen independent of such variations without further attention except for renewal of material at long intervals.

Mr. McDermet's paper shows an interesting means which may be used for mechanical deaeration of water, but he is hardly justified from the data and experience given in claiming that this process involves a minimum of operating expenses. There seems to be no doubt that the controlling factor in water corrosion is the pressure of dissolved oxygen, carbonic acid being of minor importance. The most economical and convenient method for controlling corrosion in steel economizers will be developed by experience, but that control of corrosion can be accomplished by the application of these principles I believe has been established beyond doubt; therefore, with attention to the relative temperature of waste gases and feed water so as to avoid outside condensation on tubes, there is no apparent reason why steel economizers cannot be used without any more deterioration than is now experienced in boilers.

* Discussion of J. R. McDermet's paper, read at spring meeting of A. S. M. E.



Industrial Illumination---II

REFLECTORS, LIGHTING AND LAMP CONTROL.

BY VICTOR H. TODD

VARIOUS sources of light such as the Nernst, mercury, vapor and vacuum-tube lamps have been proposed and successfully used, but present-day illuminants have narrowed down to an extensive use of Tungsten vacuum and gas-filled lamps and a limited use of arc lamps. Incandescent lamps have reached such a high stage of perfection in manufacture, efficiency and ruggedness, and can be supplied in such a variety of capacities that practically every installation can be correctly illuminated by their use.

One of the disadvantages of other lights is in the odd colors. Although satisfactory for many purposes, the modern installation regards quality on a par with quantity of light and thus eliminates lamps producing a light markedly lacking in certain rays, as for instance, the mercury vapor light.

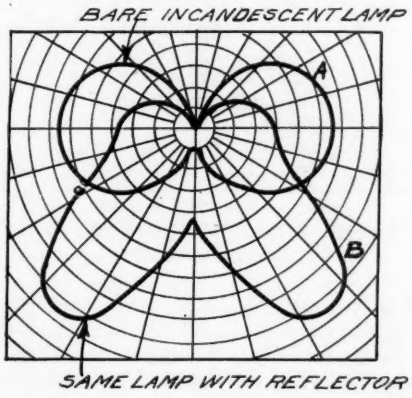


FIG. 6. SHOWING EFFECT OF REFLECTOR ON DISTRIBUTION CURVE

The old carbon filament lamps have almost entirely disappeared, as they were very wasteful in current as well as requiring very close regulation to obtain maximum life and efficiency. This leaves almost the entire field of both exterior and interior illumination to the tungsten as it excels in simplicity, efficiency, color, steadiness, cost (initial and maintenance), size and appearance.

LIGHT AND ILLUMINATION

THE TERMS "light" and "illumination" are often confused, but it should be clearly understood that light is the source of the rays, and illumination is the effect on the work. For instance, if a certain lamp is placed in a room with dark walls, and belting, etc., in the path of the rays, the light may be good, but the illumination on the work may be poor. Then, again, a small lamp may be placed near the work and while the light may not be bright, yet the illumination may be satisfactory.

REFLECTORS

IN ORDER to convert all the rays of light into useful illumination, all lamps should be supplied with proper reflectors. The function of a reflector is to intercept all the rays of light which would not otherwise reach the work and redirect them to a useful plane. For instance, in the curves, Fig. 6, the graphs show the distribution with and without a reflector, showing that the light is directed downward instead of sidewise.

Reflection is accomplished in three ways: (1) Direct reflection, as for instance, a light striking a polished surface, in which case the light is all reflected in one direction. (2) Diffusion, as when a light strikes

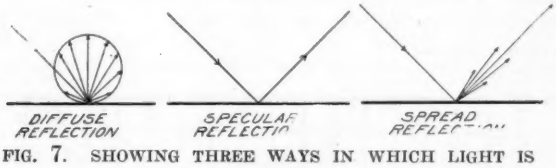


FIG. 7. SHOWING THREE WAYS IN WHICH LIGHT IS REFLECTED

a dull surface, it is reflected in all directions, and (3) where the main body of light is reflected in one direction, but with slight diffusion. Figure 7 shows the directions of rays of the three reflections.

There are also three methods of illumination, direct, indirect and semi-indirect. In the first case, the light is allowed to fall directly on the work, thus producing a maximum of illumination and wasting no light in illumination of the room. This method produces a maximum of shadows and is undesirable for such locations as drafting rooms, offices or fine assembling operations. It is accomplished by the use of metal reflectors which are closed at the top, thus throwing all the light downwards. This is the most efficient system, but does not represent the best practice where all factors, both physical and psychological are taken into consideration. Indirect lighting is obtained by placing the light in an opaque bowl and letting it shine on a white ceiling, thus illuminating the work by the diffusion of light from the ceiling. The efficiency of the best indirect

lighting is only about 60 per cent of the best direct lighting and is employed only where consideration of current consumption is of secondary importance to the absence of shadows. Semi-indirect illumination is extensively employed, as it gives correct illumination of the work and still leaves the walls and ceiling sufficiently illuminated to dispel a gloomy appearance and contribute more to the general atmosphere of cheerfulness.

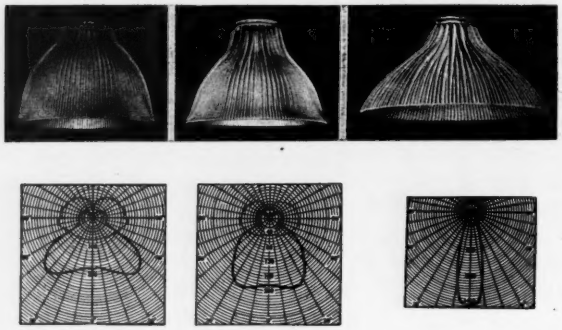


FIG. 8. EXTENSIVE, INTENSIVE AND FOCUSING TYPES OF REFLECTORS AND RESULTING CURVES

In spacing the units, it is necessary to produce proper side illumination and also to guard against excessive shadows. To this end, the lamps must not be spaced too far apart in order to use large lamps. The higher the mounting, the larger the lamp that may be used; it is generally safe to lay out squares, with a lamp in the center of each square, and the side of the square about 50 per cent greater than the mounting height. When architectural considerations make this impossible, the best way is to choose a specially designed reflector to give proper illumination with the height and spacing which must be used. This will be taken up later.

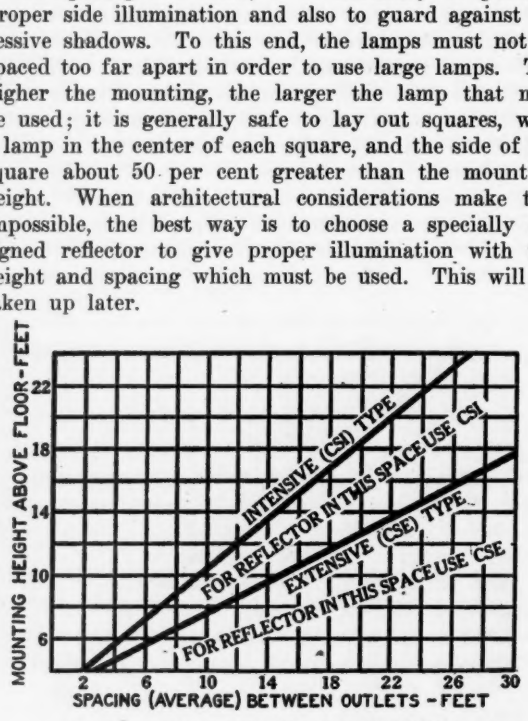


FIG. 9. HOW TO CHOOSE A REFLECTOR

The Holophane Glass Co. was the first to classify its reflectors into the extensive, intensive, focusing and concentrating types in order to accommodate any condition of relation of mounting height to spacing. The curves in Fig. 8 show the way in which these reflectors redistribute the light.

CALCULATING THE LIGHT NECESSARY

OF THE several methods of calculating the light necessary, perhaps the simplest is the total lumens of flux method. In designing an illumination system, the first point is to determine the class of work done and then from a table of illumination required, as shown in Table II, decide on how many foot candles will be required. Then lay out the floor and ceiling plan using a scale of ¼ or ⅛ in. to the foot, and on it note all obstructions such as beams, pillars, belts, and the location of large machines. If possible, divide the ceiling into squares about 50 per cent greater than the height of ceiling above the work benches, but if beams, pillars or other obstructions render this impossible, divide it into a logical number for a preliminary trial, to determine the size of the lamp and the type of reflector. If the lamp does not turn out to be a suitable size, another spacing may be tried and the size of lamps recalculated.

The second step is to calculate the total lumens required to produce the desired illumination in foot candles. The formula for this quantity is:

$$\text{Total lumens} = \frac{\text{sq. ft. area of floor} \times \text{foot candles}}{\text{constant from Table II.}}$$

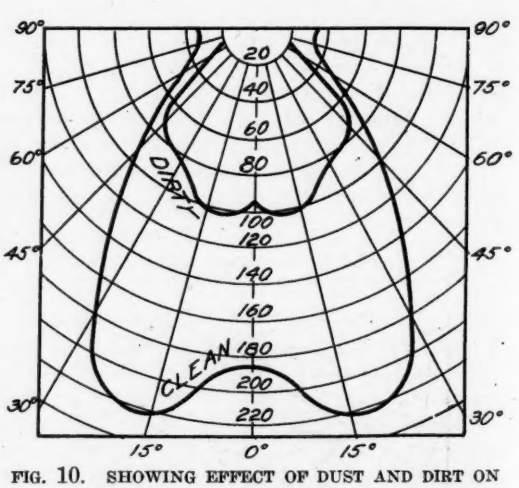


FIG. 10. SHOWING EFFECT OF DUST AND DIRT ON ILLUMINATION CURVE

In this formula, the square feet area of the floor is easily figured; the intensity of illumination in foot candles has already been decided upon and the constant depends on the kind and color of the walls.

These constants are for average size rooms. For rooms smaller than about 200 sq. ft., the constants may be 10 to 40 per cent lower, depending on the size of the room and the character of the walls. For rooms larger than 1000 sq. ft., the constants may be increased slightly, especially if the walls are medium or dark.

The third step is to determine the size of lamp by dividing the total lumens as previously calculated by the number of squares as determined from the layout drawing. If the size is not satisfactory, try another arrangement of squares, until the lamp of the desired capacity may be used.

The reflector is now determined by the ratio of the spacing to the mounting height. Figure 9 shows how to choose a reflector. Locate the height above the working plane on the vertical line and locate the size of the square on the horizontal line. The space in which

their intersection falls readily shows which reflector should be used.

Depreciation and Cleaning

These figures are for new lamps and clean reflectors. Figure 10 shows how rapidly the efficiency falls off due to the accumulated dirt. It is useless to design a good system and then let it accumulate dirt and dust until it drops to 60 or 70 per cent of its initial efficiency. It is a demonstrable proposition that it pays to maintain a regular cleaning schedule which should be rigidly followed up.

TABLE II. ILLUMINATION INTENSITIES COMMONLY USED FOR VARIOUS CLASSES OF WORK

Class of Work	Illumination Intensity at Work, Foot Candles.
Roadways and Yard Thoroughfares	0.05 - 0.25
Stairways, passageways, aisles, storage spaces,	0.35 - 0.70
Rough manufacturing operations such as foundry work, rough assembling, rough bench work and in fact all work requiring no close discrimination of fine detail.	1.7 - 3.5
Fine manufacturing operations such as fine lathe work, pattern and tool making, light colored textiles, tobacco manufacture, assembling small motors, and any work requiring a moderately close discrimination of fine detail, taking measurements, etc.	3.5 - 6.0
Special cases of fine work, such as watch making, fine instrument assembly, engraving, drafting, dark colored textiles, etc.	8.0 -15.0
Clerical Work, such as is carried on in the average office, accounting, operating typewriters, billing machines, etc.	3.5 - 6.0
Ultra-intense illumination for special cases.	15.0 - 20.0

Supply Circuits and Wiring

The subject of supply circuits and wiring is so broad that only a few general rules and suggestions may be given. The architecture of the layout will often determine what type of wiring and control must be used, and existing circuits may determine the character of the supply circuits. In this respect, are tungsten lamps unexcelled: they will operate properly on direct current or any frequency alternating current. The lower limit, however, should be 25 cycles as below this there is a tendency to flicker although this is not near so marked as in the old carbon lamps.

Wherever possible, the installation should be designed to utilize lamps of standard voltages in the neighborhood of 110. Ease of obtaining lamp replacements is an important factor, as lamps of these voltages can be obtained at any time. Below this, the copper loss becomes excessive, and above this, a 3-wire system should be employed.

As to the mains, the lighting circuit should never be connected to the power circuit if it can possibly be avoided. As shown in Table IV, the total lumen variation is considerably more than the variation in voltage, and if the lighting circuit is connected to the power circuit, there is bound to be more or less voltage variation, due to the varying load, and the worst of this is, that the lowest voltage and poorest lighting is obtained when the machines are working the hardest, and just when the best illumination is desired. When the machines are idle, the voltage is high and the illumination excessive.

TABLE III. CONSTANTS FOR USE IN TOTAL FLUE MEASUREMENTS. BASED ON GLASS REFLECTORS AND TUNGSTEN LAMPS

Constants for use in Total Flux Measurements. Based on Glass Reflectors and Tungsten Lamps.	
Light Ceiling & Light walls	.60
Light Ceiling & Medium Colored walls	.53
Light Ceiling & Dark Walls	.42
Medium colored ceiling & walls	.42
Medium colored ceiling & dark walls	.45
Dark ceilings and walls	.40

The Fire Underwriters' rules should be carefully consulted before wiring an installation in order that it may pass inspection; and it should be borne in mind that a cheap initial installation, for instance, of open wiring, is not the cheapest in the long run. For this reason, most modern installations are run entirely in conduit, both mains, feeders and branches; in fact, in many localities conduit is required. In any event, it makes the safest and neatest installation and will often be found to be the cheapest in the long run, as the danger and the maintenance are almost negligible.

TABLE IV. VARIATION OF CANDLEPOWER WITH VOLTAGE

Voltage of Lamp	Voltage of Circuit																				
	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
105	100.0	103.4	106.9	110.4	114.0	117.6	121.4	125.2	129.1	133.1	137.2										
106	96.7	100.0	103.4	106.8	110.3	113.9	117.5	121.2	125.0	128.8	132.8	136.9									
107	93.6	96.8	100.0	103.4	106.7	110.2	113.7	117.3	121.0	124.7	128.5	132.5	136.5								
108	90.5	93.6	96.8	100.0	103.3	106.7	110.1	113.6	117.1	120.8	124.5	128.2	132.2	136.1							
109	87.6	90.6	93.7	96.8	100.0	103.3	106.6	110.0	113.5	117.0	120.6	124.2	128.0	131.8	135.7						
110	84.9	87.8	90.7	93.8	96.8	100.0	103.3	106.6	109.9	113.3	116.8	120.4	124.0	127.7	131.5	135.4					
111	82.2	85.0	87.9	90.8	93.8	96.9	100.0	103.2	106.5	109.8	113.2	116.6	120.2	123.8	127.4	131.2	135.0				
112	79.6	82.3	85.1	88.0	90.9	93.9	96.9	100.0	103.2	106.4	109.7	113.1	116.5	120.0	123.6	127.2	130.9	134.7			
113	77.1	79.7	82.5	85.2	88.1	91.0	93.9	96.9	100.0	103.2	106.4	109.6	113.0	116.3	119.3	123.3	126.9	130.6	134.3		
114	74.7	77.3	79.9	82.7	85.4	88.2	91.0	94.0	97.0	100.0	103.1	106.3	109.5	112.9	116.2	119.6	123.1	126.7	130.3	134.0	
115	72.4	74.9	77.5	80.1	82.8	85.5	88.3	91.1	94.0	97.0	100.0	103.1	106.3	109.5	112.7	116.1	119.5	122.9	126.4	130.0	133.7
116	.....	72.6	75.1	77.6	80.2	82.9	85.6	88.4	91.2	94.1	97.0	100.0	103.1	106.2	109.4	112.6	115.9	119.3	122.7	126.2	129.7
117	.....	.....	72.8	75.3	77.8	80.4	83.0	85.7	88.5	91.3	94.1	97.0	100.0	103.1	106.2	109.3	112.5	115.8	119.1	122.5	126.0
118	.....	.....	.....	73.0	75.5	78.0	80.6	83.2	85.8	88.5	91.3	94.2	97.1	100.0	103.0	106.1	109.2	112.4	115.6	118.9	122.3
119	.....	.....	.....	.....	73.2	75.7	78.1	80.7	83.3	85.9	88.6	91.4	94.2	97.1	100.0	103.0	106.0	109.1	112.3	115.5	108.7
120	.....	.....	.....	.....	.....	73.4	75.9	78.3	80.8	83.4	86.0	88.7	91.5	94.3	97.1	100.0	103.0	106.0	109.0	112.2	115.3
121	.....	.....	.....	.....	.....	.....	73.6	76.0	78.5	81.0	83.5	86.1	88.8	91.5	94.3	97.1	100.0	103.0	105.9	109.0	112.0
122	.....	.....	.....	.....	.....	.....	.....	73.8	76.2	78.7	81.2	83.7	86.3	88.9	91.6	94.4	97.1	100.0	102.9	105.9	108.9
123	.....	.....	.....	.....	.....	.....	.....	.....	74.0	76.4	78.8	81.3	83.8	86.4	89.0	91.7	94.4	97.2	100.0	102.9	105.9
124	.....	.....	.....	.....	.....	.....	.....	.....	.....	74.2	76.6	79.0	81.4	83.9	86.5	89.1	91.7	94.5	97.2	100.0	102.9
125	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	74.4	76.7	79.1	81.6	84.0	86.6	89.2	91.8	94.5	97.2	100.0

Control of Lamps

There are numerous methods of control of lamps and what may suffice in one case may be totally inadequate in another. Each installation is a subject for study. As a general rule, the lamps must be arranged so that the ones farther away from the windows may be lighted sooner than those near the windows. Some-

times they are controlled in groups and sometimes in long rows running parallel to the windows. It resolves itself into a question of balancing the value of light saved by extra control against the cost of the switch and its installation and thus much depends upon the intelligence of the calculator and the reliability of his data.

Many modern installations employ an individual control for each lamp which is operated by a pull string. Several of these small individual switches may cost only as much as one large group-control switch and the flexibility of the control in this case is 100 per cent, as any or all of the lamps may be lighted or extinguished as the conditions may appear to warrant.

Direct Current vs. Three-Phase Motors for Steel Mills*

FOR DRIVE OF MACHINERY IN STEEL WORKS, HEAVY LOAD, VARIABLE SPEED AND REVERSING THE D.C. MOTOR IS SHOWN TO HAVE CONSIDERABLE ADVANTAGE IN FIRST COST AND IN OPERATION. FOR LONG TRANSMISSION THREE-PHASE CURRENTS ARE THE BETTER ADAPTED

As both direct and three-phase currents have been used largely for driving steel works, it is justifiable to consider the advantages of the two systems. Three-phase systems have the fundamental advantage of permitting transmission of power cheaply over long distances at high voltage; hence, this method has been widely adopted by central stations, and where power is bought from them, steel works have mostly installed three-phase motors. But these motors are not capable of speed variation without considerable loss of power, unless they are of special construction which adds greatly to the cost, and complicates their use for many purposes.

STEADY SPEED OVER WIDE RANGE

FOR MANY operations such as driving merchant and bar mills, heavy work must be done at low speeds and

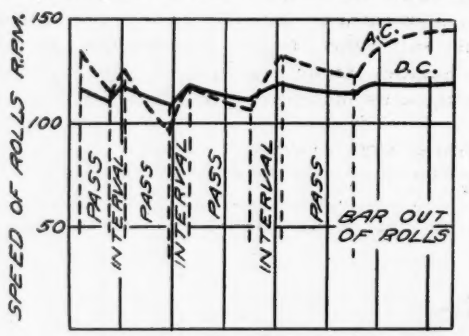


FIG. 1. SPEED VARIATION OF D.C. AND 3-PHASE MOTORS ON ROLLING MILL

light work at high speeds, yet each speed should be reasonably steady. The d.c. motor can be so regulated by a regulator in the shunt field without much loss of power, and the torque is increased at low speeds where it is needed for the heavy work. The speed of a shunt motor is, moreover, self controlled within narrow limits of variation for a considerable load variation. As an example, a 400-hp. motor has a speed range by control between 60 and 250 r.p.m., but at the lower speed setting will not run over 66 r p.m., even at no load.

An ordinary three-phase motor could be run at reduced speed only by resistance in the rotor circuit, which would involve considerable waste of power; and at the low speeds it will lose in torque, hence a large and expensive motor must be installed. Furthermore, such a motor will tend to speed up, when running at low speed, as soon as the load is reduced, and will fall in speed under heavy load.

In Fig. 1 the full line shows the action with a d.c. motor, the dotted line that with a three-phase while rolling a bar. The synchronous speed of the a c. motor was 150 r.p.m. and the regulator was set on each motor for a speed of 115 r.p.m. Variation for the d.c. motor was 8.5 per cent and for the a.c. 44.8 per cent.

The motors were 1200 hp. rating, and Fig. 2 shows the loss of power in the two motors for the operations of Fig. 1, the loss in the a.c. motor being 2.92 times that in the d c. for the operations as shown.

Devices have been used to better speed control and reduce loss of power in the a.c. motor drive; but they

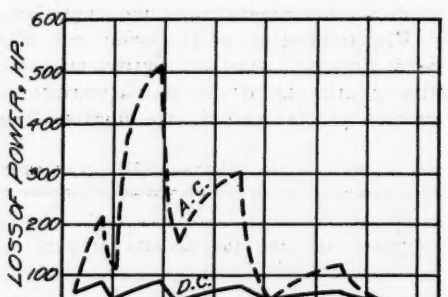


FIG. 2. POWER LOSS OF D.C. AND 3-PHASE MOTORS FOR THE OPERATIONS SHOWN IN FIG. 1

have been more expensive, more complicated, and less economical than the d.c. motor equipment.

Use of a flywheel to furnish a part of the peak power required during a pass can also be more easily arranged in connection with a d.c. motor, as the drop in motor speed during the pass can be automatically cared for by a compound winding on a d.c. motor without loss of power, while in the three-phase motor, such drop in speed is accompanied by waste of energy in the resistance used in the rotor circuit.

The author points out that for American conditions, large tonnage of a particular section, where regulation of speed is of less importance, the three-phase motor is at less disadvantage, but even then the d.c. equipment would often be more efficient than the three-phase motors that have been used.

For slow speed work such as hot sheet and plate

* Abstracted from a paper by C. A. Ablett, London, England, before the Iron and Steel Institute; reported in Engineering of London.

mills, 30 to 40 r.p.m., the d.c. motor can be installed direct connected at a considerable saving of power over rope or geared drive, which cannot be done with the a.c. motor on account of the great number of poles required for slow speed work. It is, however, probable that a direct connected steam engine may be more economical than any form of electric drive for such mills, where steam is available without extra cost for boiler plant. This does not apply to cold rolling where the load is practically constant, and there is little advantage for any one of the three drives over another.

Reversing Mills

Where reversal is necessary, the mill proper is usually driven by a motor-generator, the motor having 1/5 to 1/6 the peak power given by the mill motor when at work, the balance of the power being supplied by a flywheel on the motor-generator shaft. Speed of the motor-generator is controlled by a relay in the power circuit, increasing when load is off so as to store energy in the flywheel, and decreasing under load to let the flywheel supply power. The d.c. motor can not only reduce the power taken from the central plant, but can, in an emergency, act as a generator driven by the flywheel, turning current back into the mains, and thus steadying the demands on the generating units of the central plant. In this way the d.c. motor is about three times as effective as the a.c. in assisting the power station to carry over peak loads. Furthermore, this effect is accomplished to the extent of 20 per cent speed reduction to permit the flywheel to carry load without waste of energy if a d.c. motor is used, while an a.c. motor must be retarded artificially, and a considerable portion of the power supplied by the flywheel is wasted in the retarding resistance in the rotor circuit. This waste will be in the region of 10 per cent of the power supplied to the motor.

For quick acceleration, stopping and quick reversal, the d.c. motor has an advantage in that for a given increase of current its torque is increased much more rapidly than that of the a.c. motor. Also, if voltage falls, the torque of the a.c. motor falls as the square of the e.m.f., while that of the d.c. motor falls only directly as the e.m.f.

In the discussion on this paper, it was stated by F. P. Clarke that in many establishments it had been necessary to replace 40-hp. 3-phase motors by 20-hp. d.c. motors for driving the live rolls. He noted that in the matter of cost, the turbo-alternator was less expensive than the turbo-d.c.-generator unit, hence this might affect the difference in motor cost, but he gave no figures to support this statement.

H. Crowe mentioned a saw that was driven with a 40-hp. d.c. motor, but would require a 60-hp. 3-phase motor. The old bugaboo of commutator trouble has been eliminated from the d c. machine.

In the matter of transmission, D. Selby-Bigge suggested the Thury high-tension d.c. system as a possible means of securing for d.c. the transmission economy of a.c.

A Fortunate Mishap

The Exciting Experiences of a Birmingham Darkey with a Steam Turbine Aboard Ship. By A. W. Kramer

THEOPHILUS CONIFER WARD, on the second grating in the engine-room of the U. S. S. Western Star, paused for a moment in his task of polishing the steel hand rails to renew the supply of oil on the strip of emery cloth he was using.

"Dog-gone, but these railin's sho' deman's a pow'ful 'mount o' 'tenshun. Ah mos' used up a barr'l o' oil."

Holding the emery cloth in one hand, he aimed carefully with his oil can and directed a copious stream of lubricant toward it. Most of the oil, however, fell short of the cloth and was precipitated into the engine room, 20 ft. below. This did not bother Theophilus, however, and, it may be said here, this was his usual method of applying the oil. Oil was nothing in his young life.

"Missed it dat time," he said, as he watched the oil disappear into the maze of pipes and machinery below. "Ah 'lows a li'l oil down dere won't hurt none. Lots o' oil, tha's mah motto."

Theophilus considered himself an engineer. He was proud that he had been transferred to the engine room as third class fireman, notwithstanding the fact that he had been forcibly ejected from the galley. He had enlisted in the Navy as a mess attendant, but due to an inherent failing of his to allow most of the chinaware in the wardroom to be acted upon by the force of gravity, with consequent disintegration of said china, the executive officer had told him to "get the h—ll out of here" and never come near the galley again. So he had been given a fireman's rating and had been put to work as a general roustabout. Now he was brightening up the handrails in the engine room.

This was a job well suited to his liking. He claimed to possess mechanical ability and made no effort to conceal his self-supposed knowledge. Cultivated by the sense of his own importance, no-account mess attendants were far below his station and he displayed no reticence in telling them so.

"You po' coons ain't fit to 'sociate wid 'n ingineer," he told them scornfully on the berth deck while lashing up his hammock at night. "Run 'long, wash yo' dishes."

His mechanical ability was more fully exemplified in the adept manner with which he handled the oil can—and the oil. Fully half of his daily supply found its way to the lower levels of the engine room, and though he had been repeatedly warned to be more careful, he made no effort to stop it.

But on this particular occasion something else happened. The squirt of engine oil, instead of landing harmlessly upon the turbine or gear casing, as it usually did, landed upon the snow-white expanse of the chief engineer's cap. What made it worse, the chief had, just before coming below, fitted his cap with a newly washed cover.

"You confounded black lump of anthracite," he

roared, as he regarded the oil-besplattered cap. "Get down off that grating and come down here!"

"Yessuh, chief, yessuh. Ah's comin' down immejutly—Ah's on de run," replied Theophilus obediently as he started down the stairs.

"Golly," he thought to himself, "ol' chief am sum'at riled up. Th'ophilus, you sho' done got yo'self in bad dis time. Ah kin feels it in mah bones."

Coming below with the oil can still in his hands, he was confronted by the infuriated chief.

"See that, you big African mushroom?" he shouted, thrusting the soiled cap before Theophilus' face, "see that cap? What in thunder do you mean by spilling oil down here? Answer me, quick, before I shoot you!"

"Who me, suh?" inquired Theophilus innocently. "Hones', chief, Ah ain't spilled no oil—Ah ain't spilled nary a drop. Maybe it leaked off'n sumthin'——"

"Shut up! you lying nigger," roared the chief. "Leak h—ll. Twenty-four hours extra duty for you, do you understand? After that maybe I'll shoot you anyway. Here, take this cap and wash it, and the Lord help you if you don't bring it back clean. Furthermore, if I ever catch you on those gratings again, I'll cut your black head off."

"Yessuh, yessuh, chief, Ah un'erstan's," replied Theophilus. "Ah kin wash de cap, yessuh—you jus' watch mah, Ah'll——"

"Get out of here before I kill you," yelled the chief in apparent rage. "Get a rag and some polish and shine up these steam gages. Let's see if you're good for anything."

"I'se goin', chief, yessuh, Ah shines 'em up, suh. Golly," he said to himself, "ol' chief sho' was aggerwaited dat time, dog-gone."

"Most worthless nigger I ever saw," laughed the chief, as he resumed his conversation with Lieutenant Murdock. "Can't do anything with him, either. But to get back to our discussion—you were going to say something about this valve," he continued, placing his hand on the valve which controlled the discharge from the high pressure turbine.

"Yes," said Murdock, the first assistant engineer. "It needs repacking. It was leaking pretty badly, so I screwed up the gland temporarily, but the packing is fairly well hardened. Of course, it's not used much, and we need not bother with it now. I will enter it on my list of repairs to be made in port."

"It has never been used to my knowledge," the chief replied, "at least not since I've been aboard."

"No," agreed Murdock, "it hasn't. I wonder what would happen if someone should close that valve with both machines running."

The chief laughed. "Only one way to find out," he said. "Try it."

"Not today," retorted Murdock smilingly, "we're going fast enough as it is."

The valve which was the subject of their discussion was a large 10-in. gate valve in the inter-connecting line between the high and low pressure turbines. The exhaust from the high pressure unit discharged through this line directly into the low pressure unit. In case of accident to the low pressure unit, the valve in question could be closed, thereby preventing entrance of steam into the disabled turbine. At the same time another valve could be opened which would bypass the exhaust from the high pressure unit directly into the condenser. The high pressure turbine could thus run independently of the low pressure unit. However, if, as Murdock conjectured, someone should close the valve in question without first opening the bypass valve, full steam pressure would be impressed upon the high-pressure turbine casing and, with the discharge closed, the consequence of such a condition can be readily anticipated by any engineer. The turbine would probably blow up. Therefore, the absurd supposition amused the two engineers.

Theophilus, however, who began to polish the steam gages a few feet away, and who had overheard the conversation, was not impressed with the absurdity of Murdock's remark. The valve wheel they referred to, he reckoned, was no different from any of the other numerous wheels all about him.

"Why don' dey use it?" he wondered. "Wafo' dey put it heah iff'n nobuddy turns it. Might jus' as well leave it off."

"Dog-gone," he grunted, as he rubbed the brass work on the pressure gages vigorously, "de'se li'l clocks shol'y 'quire a tremenjus lot o' rubbin'. Don' sees what dey's all good fo' anyway. Wis't Ah wuz back in Bummin'ham."

* * * *

At ten thirty that night, Theophilus was finishing the first five hours of the 24 hr. extra duty imposed upon him by the chief. He was alone in the engine room with Ensign McKenzie, the officer on watch, as the engine man had been sent to inspect the steering engine. Shortly before Theophilus was ready to go above, one of the colored mess attendants came down with the customary sandwiches and coffee which was served to the officer on watch at that time every night.

"Put the tray on the lathe in the corner of the engine room," directed McKenzie, "I'll eat it there where it's a bit cooler."

The mess boy did as directed and, while waiting for McKenzie to finish eating, walked over to gossip with Theophilus.

"Lo, Theo," he said. "What yo' all doin' down heah t'night?"

"Meanin' me?" inquired Theophilus with affected unconcern, leaning leisurely against the turbine casing. "Why you po' nigger, Ah's ingineerin', Ah is. What you 'spect Ah wuz doin'?"

"Yo' ingineerin'?" queried the boy suspiciously. "G'wan, coon, what yo' all knows 'bout ingineerin'?"

"Nebber you mine; Ise fo'got mo' ingineerin' den you kin evah 'spect t' knows. Ah knows all dere is 'bout it. Ol' chief wouldn't put me down heah iff'n Ah didn't. Chief's got a pow'ful lot o' conf'dence in me," retorted Theophilus importantly.

"Huh, dat's nuthin'—how fas' we'se goin'?"

"How fas'? What does you care how fas' we'se goin'?"

"Yo' don' knows."

"Don' tell me Ah don' knows, nigger," warned Theophilus, "Ah'll bust you one."

Looking around at the vacuum gage, he studied it carefully for a moment. "We'se goin' jus' 29 knots a minute," he announced finally.

"Twenty-nine knots a minute? Am dat all? Dat ain't fas' a-tall. Cain't yo' make 'er go fas'er?"

"Co'se we kin, but we don' wan's ta."

"Ah don' b'lieve yo' kin. Show mah'!'

"Waf fo'll Ah show you, you no-'count mess cook—you don' knows nuffin 'bout m'chinery."

"Ten dollahs says yo' cain't."

"Yo' ten's mine, coon—you sees dat dare wheel? Well, all Ise got t' do is t' turn dat wheel an', zip! fas'er we'se go."

"Go 'head an' turn it. Bet you's 'fraid."

"Me 'fraid? Ah ain't skeered o' nuthin'."

"Turn it!"

"All right, Ah'll show you. Ise ain't skeered. Stan' back, nigger, outen de way," ordered Theophilus as he strutted towards the valve.

To tell the truth, he was rather scared, but his bluff had been called and he could not back out. Anyway, there wouldn't be any harm in turning the valve, he deliberated; hadn't Lieutenant Murdock himself said that very morning that he'd like to know what would happen if someone turned it? It probably was of no use at any rate.

Grasping the big wheel with both hands, and standing with his legs astride, he hesitated just a moment.

"Go on, turn it," urged the mess attendant.

With one mighty effort, Theophilus sent the wheel spinning. For a brief instant nothing happened—only for an instant, however. Then suddenly the shrill note of the turbine fell—the machine groaned, quivered, and as the now-terrified Theophilus stepped backwards it seemed as though the bottom of the ship was lifted from under him. A sharp hiss of live steam, a deafening explosion and darkness closed in—and he knew no more.

* * * *

At the same time, or rather a few moments before, Lieutenant Murdock on the forward bridge deck stood at the rail talking with the executive officer. They had just finished a friendly game of cards in the wardroom and before turning in stopped a few minutes to admire the splendid moonlight night. The weather was ideal—the unruffled waters were only disturbed by the gentle ocean swell.

A number of the thirty-odd ships which made up the convoy were plainly visible around them. An impressive sight—35 dark, silent, little ships, their bows all pointed one way steaming silently through the night.

Murdock, who had been looking intently out into the water for a few moments, suddenly drew back and clutched his brother officer's arm.

"Look, Mr. Lang," he whispered excitedly. "A submarine! do you see her?"

"No, where?" was the quick response.

"Out there," said Murdock, "see the streak of her periscope—she's running submerged."

"By George, you're right—she's running parallel with us. Hurry, there is no time to lose; she is probably getting our range now. Order out the gun crew while I go up to the bridge to—

His words were cut short by the shock of a muffled explosion and almost instantly the engine room skylight was shattered by a heavy body which crashed through it. The clouds of steam which followed furnished conclusive evidence of a calamity down below.

"Too late, Murdock," cried Lang, "they have torpedoed us. It has evidently struck in the engine room."

"No," replied Murdock, "that was no torpedo, I am almost certain. Look! we are changing our course."

The ship was swerving sharply to port moving under the force of her own momentum, and since the explosion, which had stopped the engines, had almost completed a right angled turn. The "Bridge" had evidently thrown the rudder hard over so as to double back on the course. Suddenly a white streak made its appearance upon the surface of the water and passed within 10 ft. of the vessel.

"The torpedo," they exclaimed simultaneously, "just missed us."

"Our quick turn saved us," said the executive officer, "but what caused the explosion in the engine room? Not the torpedo, that's certain. We had better investigate at once."

By this time, the enemy submarine had been sighted by several of the other ships who immediately opened fire on her and without any attempt to show fight, she submerged and escaped.

The engine room was found to be an absolute wreck when the officers finally made their way below through the darkness. Fortunately, however, the dynamo room was untouched and in the course of an hour they were able to put the lighting plant into commission.

The high pressure turbine, which had exploded, was a total loss. The eight-inch shaft of the heavy rotor had broken off and the rotor itself was found in an upright position against the gear casing. Of the turbine casing, scarcely anything remained. Part of it had been blown through the skylight and fragments had disabled practically all the auxiliary machinery in the engine room. One piece had gone clear through the steel bulkhead into one of the cargo holds.

No one had been killed, however. McKenzie, the officer on watch, was struck in the arm with a flying fragment of steel, but was otherwise unhurt. The mess attendant who had indirectly been the cause of the accident was badly burned by live steam, and considerably bruised.

Of all those near the scene of the explosion, Theophilus was the least hurt. He was found on top of the wrecked main condenser, dazed and greatly frightened, but otherwise very much intact.

"Golly, cap'n, sir, dere wuz sho' a pow'ful kick in dat dere wheel," he jabbered to Murdock as he climbed slowly down from his high perch where the force of the explosion had tossed him. "Ah's ain't neveh gwine turn 'nutheh wheel in mah life. Whuff! Ah's got no mo' ap'tite fo' ingineerin'. Ah's froo!"

"Wheel?" questioned Murdock wonderingly, for he had no conception as to the cause of the accident. "What wheel?"

"De wheel what meks de boat go fas'er, cap'n. Ah showed dat no-'count mess cook how it wuked."

"You mean you turned the throttle wheel?" demanded Murdock.

"Yessuh cap'n, de wheel you wuz showin' de chief dis mawnin', yessuh."

And then it dawned upon Murdock that it was not the throttle valve that he referred to, but the discharge valve of the high pressure turbine. That accounted

for the accident! Theophilus had closed the discharge of the turbine!

"You black rascal," he shouted, "so you started all this. Who told you to touch any valves down here—do you realize what you've done? Come with me! You won't lay your hands on any more valves for a long time, I can assure you of that."

"No, suh, you sho' done sed it, cap'n. Ah's ain't gwine touch 'notheh wheel no mo'. Ah's froo."

* * * *

The evidence submitted at the investigation which followed on board the next day while the disabled ship was being towed in, proved conclusively that Theophilus was responsible for the accident, and without further delay his case was recommended for a general court martial.

"His ignorance can be no excuse for his action, gentlemen," said the captain who conducted the investigation. "If in the course of his duties an accident of this nature had occurred through ignorance, there might have been grounds for leniency. But under the circumstances, he knew that in turning the valve he was deliberately violating all rules and regulations, and in so doing, not only wrecked a hundred thousand dollars worth of machinery, but endangered this ship with its entire crew as well. It is a most serious offense and he must be punished."

The chief engineer was about to agree with the commanding officer when the proceedings were interrupted by the entrance of the radio operator with a message from the flagship of the convoy.

"Just a moment, gentlemen," said the captain, "this may be important."

"Listen to this," he continued a moment later, "it's a message from the commander of the convoy. I'll read it to you, gentlemen."

"'Commanding Officer,
U. S. S. Western Star:

Observed skillful manoeuvering last night. Name man deserving credit. Will be recommended for D. S. M.

(Signed) F. E. Carty.
Commander.'"

"That's fine," commented the chief. "I presume the man that message refers to is Mr. Wallace here, he was officer on watch at the time."

"No, indeed," corrected Wallace, "I didn't see the submarine nor the torpedo—in fact, nobody on the bridge did until the other ships fired on her."

"If that is the case, then what caused you to swing the ship around so suddenly?" asked the captain.

"That's just what I wanted to make clear at this investigation," explained Wallace. "We did not change the course—it changed itself. We had nothing to do with it. The steam steering apparatus went out of commission with the explosion in the engine room, and before we could get the hand steering apparatus in working order, the ship had turned through 90 deg. The hand steering gear is being used now."

"Do you mean, then," asked Lieutenant Murdock, interrupting, "that the explosion in the engine room put the steering apparatus out of order and as a consequence swung the vessel around?"

"Exactly," replied Wallace, "that's just what happened."

And an immediate examination corroborated this surprising bit of evidence. One of the copper tubes of the telemotor system where it passed through the engine room had been severed by a fragment of the exploded turbine, and as a consequence all the liquid had drained out. It may be said here for the information of the reader that the telemotor is a type of hydraulic control by means of which the steering engine at the stern of the ship is controlled from the pilot house. One of the lines having been damaged, the pressure in the system had become unbalanced, thus causing the rudder to swing to one side.

* * * *

"—it is therefore apparent, gentlemen," concluded the chief engineer addressing the members of the investigating committee later on, "that the deviation in the ship's course was the direct result of the explosion. The explosion therefore saved the ship."

"And," added the captain, "the direct cause of the explosion was—"

"Theophilus," finished the chief.

"Then his name goes to the flagship," laughed the captain.

Time to Push the Public Works Department

IN the movement to secure a National Public Works Department, a halting point has been reached by the adjournment of Congress without action on the pending bills. This does not denote any wide opposition in Congress, as these bills were pushed to one side along with many others in the last rush over delayed appropriations and matters having political significance. The proposed legislation was recognized as logical and helpful to the interests of the country; but due to lack of understanding of its purpose, an adverse vote was rendered by the members of the Chamber of Commerce U. S. A. on a referendum ballot. If members of the various commercial organizations in different cities had fully understood the intent of the movement, and that minor provisions of the bill for establishment of the Department of Public Works were subject to modification, it is likely that their votes would, in many cases, have been favorable rather than unfavorable. As it was, the total vote was small, only 477 members out of 1250 voting on the matter.

Engineers who believe that public works and public matters of an engineering nature can best be handled by a Department presided over by an engineer, and those who feel that the business of the government should be run on the same efficient basis as that of a private concern, may and should well spend time and effort in convincing the business men of their communities, and especially the members of the Senate and House of Representatives, who are now for the most part at home, that a Department of Public Works is logical, desirable, and a move toward government efficiency.

Facts, which in themselves are sufficient argument, can be obtained from M. O. Leighton, Chairman, McLachlen Bldg., Washington, D. C.

Excess is an arch enemy of success.—Forbes Magazine.

Power Plant Troubles

Treating of a Number of Causes of Trouble and How They Were Removed. By H. A. Jahnke

THE water connection on a water column attached to a return tubular boiler was arranged as shown in Fig. 1, and there was trouble due to mud and scale lodging in the pipe between the valve A and cross B. To remedy this trouble, the plug C was removed at the next cleaning and a nipple and valve put in its place as shown by the dotted lines. After this, whenever the column was blown out, this valve was also opened to remove the mud and scale in the pipe between the valve and cross.

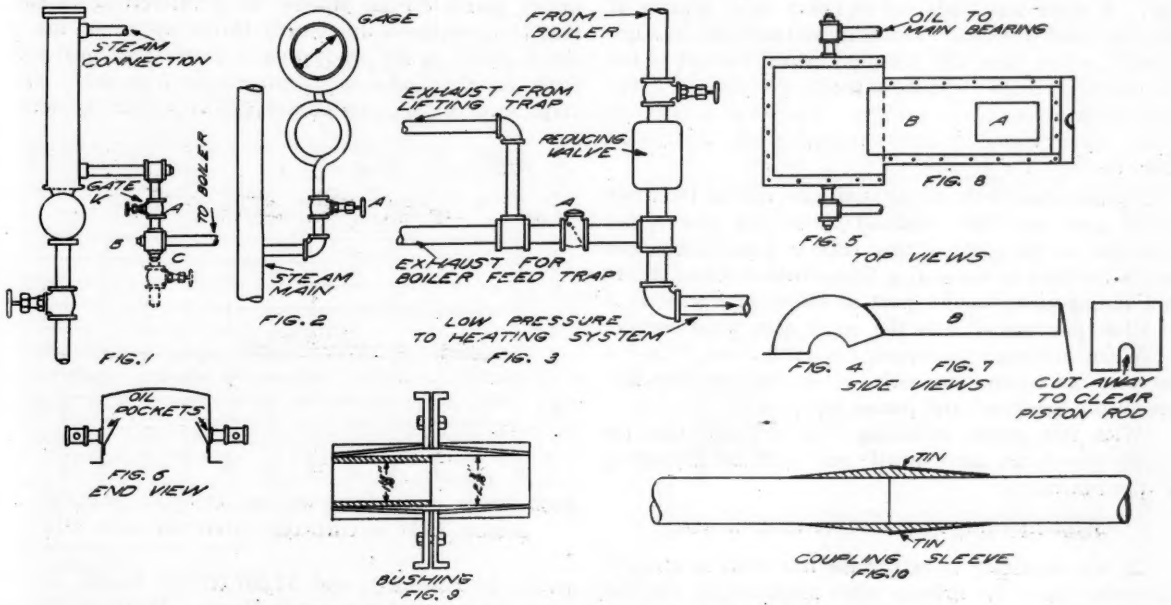
Preventing Steam Gage Hand From Moving Up and Down

At times it is necessary to attach a steam gage to the main steam pipe of an engine as shown in Fig. 2. For some reason in a case of this kind the gage hand will move up and down at the opening and closing of the engine valve, which makes it impossible to tell where the pressure is. To prevent this moving up and down of the hand, I usually place a globe valve between the gage and main steam pipe as shown in Fig. 2 at A. This valve is closed sufficiently till the quick movement of the hand ceases.

Why the Trap Did Not Work

Some time ago, I connected up a tilting trap to be used for boiler feeding. There was considerable piping to be done so I worked one whole Sunday and part of the night to complete the job, as the trap was needed badly the next morning. When the piping was completed, the water and steam turned into the trap, and I expected there would be no trouble; but after waiting a short time for the trap tank to fill with water so the trap would operate, I found that the trap would not force the water into the boiler after it had tilted to the discharging position. This was a puzzle to me, as I was sure that all was as it should be. After trying for some time to get the trap working, I gave it up until the next morning. It occurred to me that perhaps I got the steam and exhaust or vent pipes reversed. Sure enough, after examining these pipes I found this to be the trouble. After making their connections right, the trap started to operate at once.

In my haste to get the trap connected up the day before, I made the mistake and it took some quick and hard labor to get things going on time. I am merely relating this experience to show what is likely to happen at times when one is in a hurry. Be sure you are right, then go ahead, whether the apparatus is needed badly or not, to save worry and trouble later on.



SHOWING HOW A NUMBER OF TROUBLESOME LAYOUTS WERE CORRECTED

Cause of Back Pressure in Trap Tank

For returning the condensate from the heating system to the boiler we use tilting traps. One is used for boiler feeding, while the other is a lifting trap which forces the returns from the heating system into the tank of the boiler feed trap. At night and when the plant is not in operation, both traps exhaust into the heating system on the low pressure side which is what is usually called a closed system, as no condensate goes to waste; all is returned in the boiler. One day it was necessary to put more water into the boiler, which was done by opening a valve in a pipe line leading from a tank to the boiler feed trap. For some reason, however, no water would run from the tank into the trap. I was sure that there was water in the tank and that the pipe was clear. In looking further for the trouble, I found that the check A, Fig. 3, near the heating system, leaked badly.

This check valve is there so that no pressure may back up into the trap tank through the exhaust pipe from the heating system. In this case, this valve started to leak badly, so the pressure in the trap tank was above that of the water pressure in the water tank, hence no water would run into the trap tank except that which was forced into it by the lifting trap. The layout of the exhaust pipes leading to the heating system from both traps is shown in Fig. 3. When the check valve was repaired, there was no further trouble in getting water into the boiler.

Changing the Oiling System on Engine

An old type high speed center crank engine had its crosshead crankpin and two main bearings lubricated by means of grease and oil cups. To eliminate the trouble of frequent hot bearings and doing away with the filling of the grease and oil cups, the oiling system was changed to that of the splash system in the following way. A cover was made out of heavy sheet iron to fit over the crank disks and connecting rod as shown in Figs. 4 and 5, which show also the pipes which lead oil to the two main bearings. Figure 6 shows a section of cover over crank disks and oil pockets. The cover is fastened to the engine frame by screws in such a way that no oil leaks through the joint.

Figures 7 and 8 show a top and side view of the cover which goes over the crosshead slides and piston rod. This part of the cover is also made of heavy sheet iron and is fastened to the engine frame with screws. There is a sliding cover in this part as shown in Fig. 8 at A to allow pouring oil into the crank case when needed.

When necessary to repack the piston rod, it is not necessary to remove the entire cover, only the one that covers the crosshead and piston rod part B.

With this system of oiling, I have found that the engine runs much more quietly and with less keying up of the bearings.

Reducing One End of a Shaft Coupling

It was necessary to extend the line shaft in a manufacturing plant for driving more machinery. The line shaft in the plant was 2 3/16 in. diameter. As there was a length of shaft in the plant of the required length but 1 15/16 in. diameter, it was decided to use this, but it required a reducing coupling. In looking over the stock, I found a compression coupling for the 2 3/16 in. shaft. To make use of this coupling, I made a bushing the bore of which was 1 15/16 in. to fit over the smaller shaft while the outside diameter was 2 3/16 in. to fit into the sleeve of the compression coupling as shown in Fig. 9. This did the work and was much cheaper than if a new coupling with one end reduced was bought.

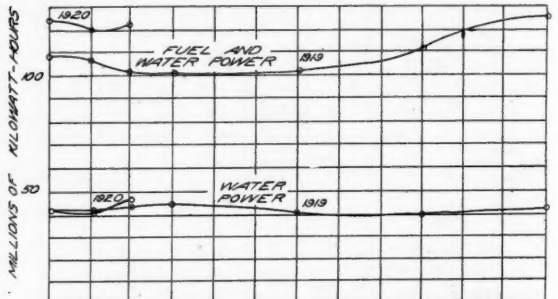
Making a Shaft Coupling Hold

In another instance while coupling up two lengths of line shafting with a compression coupling, I noticed that the sleeve would not take hold of one end of the shaft as it should and it was impossible to draw up on the coupling bolts to compress the sleeve more to the shaft. As the line shaft was needed badly, I thought of trying the coupling to see if it would hold; but after the load was on, the coupling slipped on the shaft. In measuring both ends of the shafts I found that the one which would not hold was a little smaller in diameter than the other. As there was not the time to get a sleeve made to fit the smaller shaft, I decided to get out of the difficulty in the following way: A piece of tin was fitted over the sleeve on the end where the small shaft entered as shown in Fig. 10, then the coupling was placed over tin and sleeve and bolts drawn up. After this the shaft pulled the load without slipping in the sleeve.

In placing the tin over the sleeve, it allowed the coupling to compress the sleeve much more on this end so it would hold. This repair was made some months ago and there is no sign of any trouble.

Power Production for March

THE accompanying curves plotted by A. H. Horton of the U. S. Geological Survey, show an upward trend in the production of electricity by public utility plants during March. It is interesting to note that the increase is due chiefly to the additional use of water power, as the production of power developed with fuels, increased by a comparatively small amount. One state, Connecticut, produced 8,553,000 kw.-hr. by water



PRODUCTION OF ELECTRICITY BY CENTRAL STATIONS IN MARCH, 1920, AS COMPARED WITH THE YEAR 1919

power in February, and 17,607,000 in March, an increase of over 100 per cent in March. While the figures for Connecticut are not indicative of those for the whole country, some states showing a loss, and others a small gain, it is nevertheless true that most states where water power is available, are either holding their own or show an increase in March. The actual figures for February show a production of 1,161,543,000 kw.-hr. developed by water power, while the total for March is 1,418,233,000 kw.-hr. Fuel-burning plants on the other hand produced 2,313,862,000 kw.-hr. in February and 2,358,869,000 kw.-hr. in March.

In Oregon, Washington, Idaho, Minnesota, Wisconsin, California, Louisiana and Florida a total of 17,000,000 kw.-hr. was produced by wood burning plants. This amounts to 0.4 per cent of the total production of the country for March. The fuel burning plants consumed during the month 3,316,438 short tons of coal, 1,056,763 bbl. of oil and 1,888,386,000 cu. ft. of natural gas. The curve shows that the total production exceeds by a considerable amount that for the same month in 1919. The water power production in March exceeds the peak of last year's curve.

Safeguards Against Fire

A Few Standards Based on the Underwriters' Rules

PRESENT efforts towards reducing losses from fire are based on the "ounce of prevention" principle. The Underwriters' Rules are very rigid in some of their requirements looking towards the prevention of fire.

The illustrations herewith are from the latest additions to the great American Insurance Co.'s "Green Book" of standards. Figure 1 shows a typical small gas engine and its piping and auxiliaries.

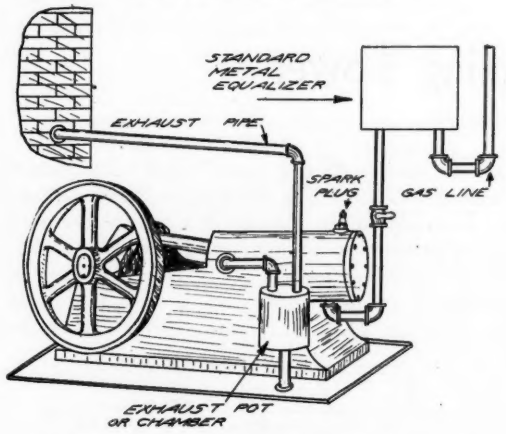


FIG. 1. SAFE GAS ENGINE INSTALLATION

The rules require that where the engine stands on a wood floor, a metal plate shall be provided under the engine and extending 24 in. on all sides. The edges are to be turned up to form a pan for catching excess oil.

Exhaust pipes must be at least 9 in. from any combustible material, and must not pass through wooden floors or decks. Galvanized iron ventilated thimbles,

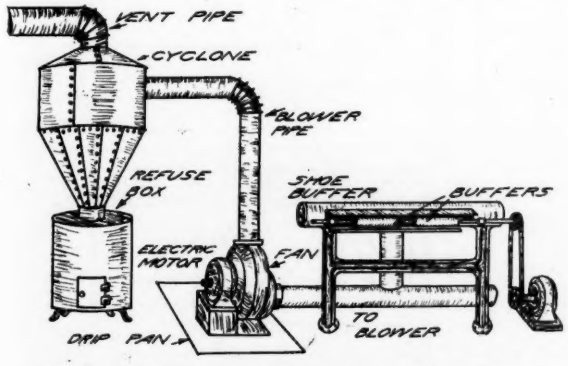


FIG. 3. ILLUSTRATING REQUIREMENTS FOR BUFFER INSTALLATION

12 in. larger in diameter than the pipe, are required where such pipes pass through combustible partitions. When a brick chimney is used for the exhaust, the exhaust pipe must pass inside the brickwork and extend upward to a point 6 in. above the top. The chimney is not to be used for any other purpose. The exhaust pot or chamber should rest on an iron or brick base, but must not be in contact with wood blocks or floor.

Hot tube ignition is allowed only in old installations, electric ignition being preferred. When the old style rubber bag equalizer is used, it must be enclosed in a metal case and the case vented to the outside air. Metal shields should be provided to catch oil thrown from the moving parts.

Figure 2 is a diagram of the fundamental parts of a standpipe system. The roof tank should have a capacity of at least 3500 gal. and should be provided with a float operating electrical signals in the engine room.

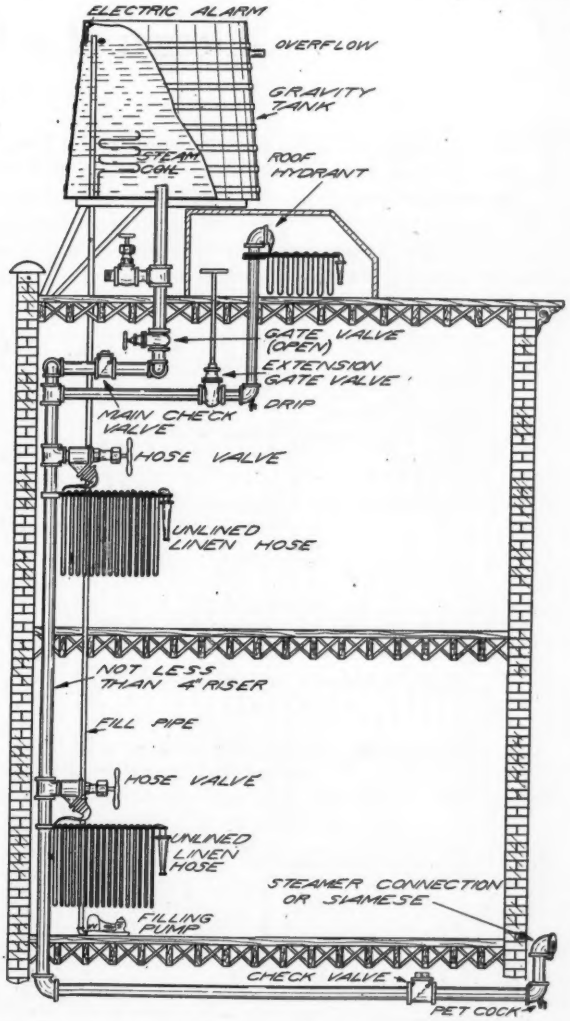


FIG. 2. DIAGRAM OF ESSENTIALS OF A STANDPIPE SYSTEM

A gate valve should be provided in the upper story of the building, for shutting off the tank in case of necessity. Normally it should remain open.

The hose provided on each floor must be unlined linen, each about 50, but not over 75 ft. in length. An additional rubber lined, linen hose is located convenient to the roof, either in a special compartment, or in the bulkhead of the stairshaft. The pipe supplying the various hose must not be less than 4 in. in size. A steamer or Siamese connection is to be provided on each

street on which the building faces. Check valves are provided as shown, one against the tank, the other against the Siamese connection.

In case the house water supply is taken from the roof tank, the outlet should be high enough and the tank large enough to maintain a reserve of at least 3500 gal. for fire protection. The tank is further to be provided with a steam coil to keep it from freezing. It must be located at such a height as will give a minimum lead of 20 ft. at the top floor hose connection.

Dust from buffing and grinding operations is frequently the cause of serious fires, as dust from almost any material, if mixed with the proper amount of air, will explode when ignited. Buffing and grinding wheels should, therefore, be provided with hoods and dust-tight ducts to carry the dust to a cyclone or separator, thence into a metal refuse box or vault. The cyclone and refuse box must be located outside of the building if possible. If inside, ventilation must be provided to outside air.

Blower pipes should not pass through floors or fire walls. If buffing wheels are located on more than one floor, the blower pipes on each floor should discharge into separate receptacles, or into a main pipe outside the building leading to a common cyclone and refuse box or vault. The blower fan should be provided with a metal drip pan extending some distance on all sides.

Design of a Cooling Tower

By R. L. Mossman

THE ACCOMPANYING drawings illustrate a forced draft cooling tower built by the writer, to cool the condensing water from a jet condenser, which served a 300 kw. turbine. This tower was erected in western Tennessee. The summer temperature and humidity as obtained by the Weather Bureau, was about 85 deg. and 75 per cent humidity.

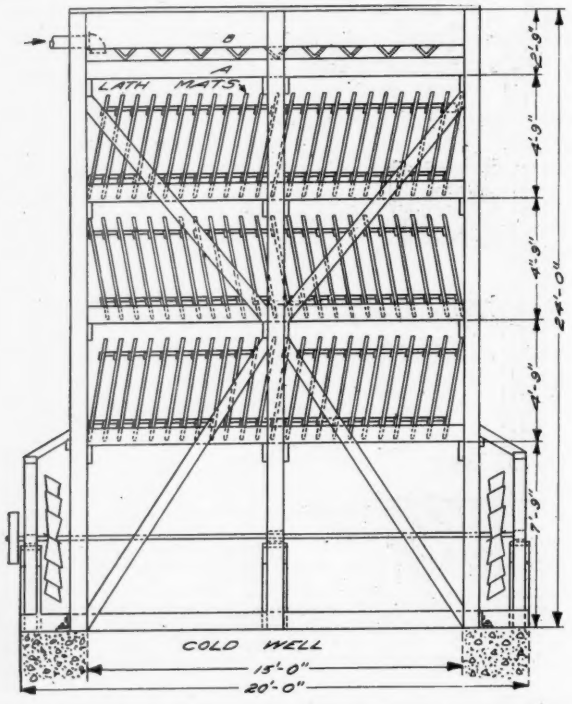


FIG. 1. SIDE ELEVATION OF TOWER SHOWING POSITION OF MATS

In estimating the air required for tower, the following was assumed. Dry bulb 85 deg.; wet bulb 78.6; humidity 75 per cent; water to tower 100 deg.; water from tower 85 deg., which gave 15 deg. cooling. The air from the tower is within 5 deg. of the water temperature, or 95 deg. with 100 per cent humidity. From the psychrometric chart, the weight of vapor in 1000 cu. ft. of air at 95 deg. and 100 per cent humidity is 2.469 lb. and at 85 deg. and 75 per cent humidity the weight is 1.374 lb. The difference is 2.469—1.374=1.095 lb. In addition the volume of air is increased in proportion to the absolute temperature, which is 460 + 85=545, and 460 + 95=555. 555÷545=1.018 the ratio of increase of volume. 1.018 × 1.095=1.115 lb. of moisture which is taken up by each 1000 cu. ft. of entering

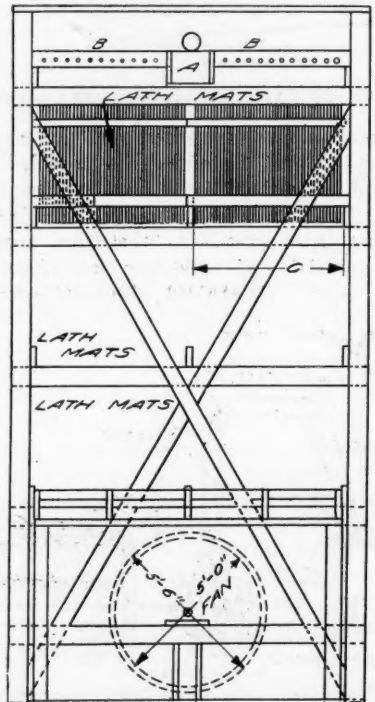


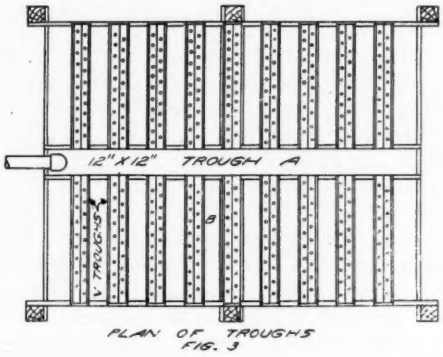
FIG. 2. END ELEVATION OF TOWER

air. The latent heat of air at 95 deg. is 1038 B.t.u. This multiplied by the moisture taken up by the air is 1038 × 1.115=1157 B.t.u., which equals the total heat taken from the water by evaporation.

The heat taken up by convection is estimated as follows. The specific heat of air is 0.237. The weight per cubic foot of air at 95 deg. is 0.071 lb.. 0 071 ×

0.237=0.017 B.t.u. required to raise one cubic foot of air one deg., 0.017 × 1000=17 B.t.u. required to raise 1000 cu. ft. of air one deg. The air being raised 10 deg., it will take from the water 10 × 17=170 B.t.u. by convection from each 1000 cu. ft. of air. This added to the amount taken up by evaporation is 1157 + 170= 1327 B.t.u. taken up by 1000 cu. ft. of air. Each pound of water cooled gives up 100—85=15 B.t.u. 1327÷15= 88 lb. of water cooled 15 deg. by each 1000 cu. ft. of air.

The steam consumption of the turbine at 300 kw. load was 22 lb. per kw. hr.= 6600 lb. per hr. Allowing 65 lb. of condensing water per pound of steam will give 6600 × 65 ÷ 60 = 7150 lb. of water per minute over the tower. As the water from the boilers taken from the condensing water, the steam condensed is not added to the tower water. 7150 ÷ 94 = 81, or approximately 81,000 cu. ft.



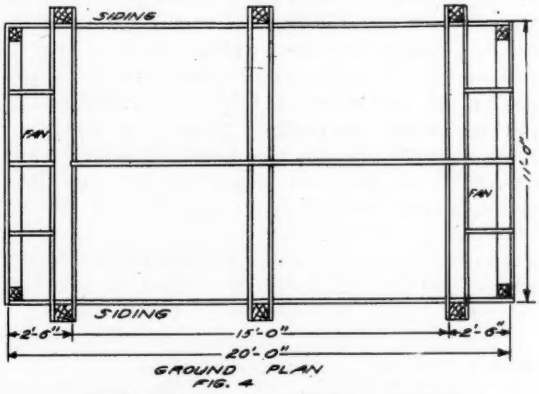


FIG. 3. PLAN OF DISTRIBUTING TROUGHS
FIG. 4. GROUND PLAN OF TOWER

of air required per minute. Two 5-ft. fans were used as shown, the speed of the fans being regulated as required by weather conditions and the load.

The drawings show the frame work of the tower without the sides, the tower being boarded up except at the fan openings. The filling used was ordinary building lath. About 13,000 lath were required. The lath mats were constructed as shown in Fig. 5, each lath separated the thickness of a lath by blocks E, cut from the lath. Each mat was made in two sections, the total length of both sections being 10.5 ft. or the distance C for one section. Twenty-four mats were put in each tier. The three tiers gave 756 running feet of mats. Each running foot is equal to 20 sq. ft. of surface, which made the total surface 15,121 sq. ft., not including the sides of the tower. This gives about 28 lb. of water per hour per square foot of mat surface.

Figure 1 is a side elevation of the tower showing the mats in position. The mats are separated 7.5 in., by distance pieces D, Fig. 5, inclined about 9 in. from the vertical, and supported by 2 by 8-in. joists. The posts of the tower are 8 by 8-in. Figure 2 is an end elevation of the tower with one tier of mats in place. Figure 3 is a plan of the top showing water distributing troughs which consists of main trough A, with branch troughs B, spaced 18 in. apart, and having

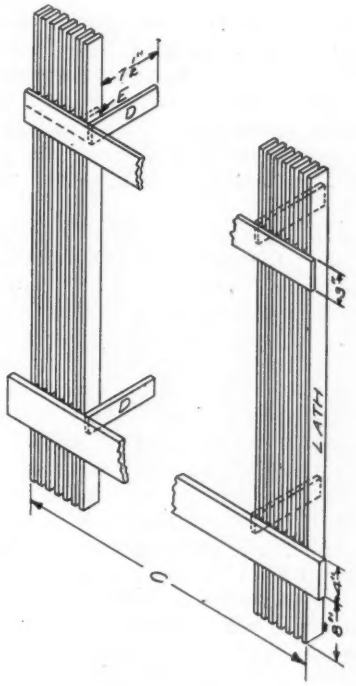


FIG. 5. DETAIL OF LATH MATS

⅝-in. holes bored about 4 in. apart as shown.

The following results were obtained from this tower in the month of July with an outdoor temperature of 83 deg. and 75 per cent humidity.

Kw. load on Turbine.	Vacuum inches.	Temperature of water to tower, degrees.	Temperature of water from tower, degrees.
130	27.5	96	84
240	27	108	92
310	27	106	92

Coal Production in Colorado

DURING the month of May the production of coal as shown in the state coal mine inspector's report was 880,316 tons. The total production from Jan. 1 to June 1, 1920, is 4,138,807 tons, an increase of 869,150 tons over the same period last year. The number of men employed in the mines is 12,550.

DEFECTIVE FLUES are responsible for 13 per cent of all the fires.

Experiences at the Glendale Plant

WALLACE RELATES AN INTERESTING EXPERIENCE WITH A COUPLE OF AIR COMPRESSORS. BY G. H. KIMBALL

SINCE the last letter between them, Wallace visited his old plant and found that under the direction of Mr. Gooch, the place was fast running down. Thus there was not much for Blake to write that would be news, so several months went by before any letters were written and then it was Wallace who had the long story to tell.

Bridgetown, Mar. 1, 1911.

Dear John:

You have not heard from me for some time because I have been so busy that it has been hard to write. At the time I saw you in Glendale, the power house here was very well closed in, but soon after the carpenters began to put in the forms for the columns and liberal openings were made to let them in. Afterwards there were big holes around the forms that let in lots of cold air.

They also began to excavate at the front end of the building where the compressors were and since they were afraid that the soil would not hold them they had to be moved to the opposite end and a lean-to was built over them. The concrete base walls of the new building had been poured and as it runs about 3 ft. above the floor, in getting the last compressor over it they let it fall and sprung the shaft. This is a short straight shaft with the crankpins on the flywheels and it had to be taken out, the wheels pulled off and a new one made and the wheels pressed onto it. All this took valuable time. In the middle of it, the other compressor broke its crosshead and there was some quick hustling one morning to take the crosshead from the one that had the sprung shaft and put it in the other, as well as the high and intermediate piston rods which were bent.

There seemed to be no reason for this break and we were lucky to get along all right until both compressors were in order and then soon after, everything was going all right and smash went the crosshead on the same one again. The queer part was that these have run so long without giving any trouble and they are made very heavy of cast iron. After this break, I suggested steel castings and the matter was taken up with the manufacturers, who said that they would supply them. Before any came, however, and while one machine was out of commission, another crosshead broke one afternoon about 5:30; all of the factory lights were on and when the load from our engines was dropped from the steam plants, they went down and out, too. Then we worked until midnight, getting the machine fixed up, and one of the new crossheads coming just in time so that we could put it on, we stayed all the rest of the night at the main factory steam plant where it was warm. Since that time, no more have broken, and it seems as if the steel castings were the best to use.

About this time, a gang of carpenters came in and began to put up shores for the roof girders which are to be of reinforced concrete 5 ft. deep and 1 ft. wide. The weight of these and the roof which will also be of concrete needs something to hold it that is strong, so they put up 4 by 4-in. shores about 8 ft. apart under each girder. They surround the engine and the switchboard and it looks like a forest. Naturally, they interfere greatly with the operating and care of the machinery. With the compressors outside the wall, we must climb up steps and then down every time that we go out there to oil them.

It was chilly here by that time and there was a long box stove that we set up and we could keep warm around it in the dusk of the room with the smoke pipe running up and losing itself in the shadows of the roof timbers. The officials were afraid that it would set fire to the building, so it was removed and some steam supplied from the plant across the river which sent it across at 75 lb. pressure; a trap was put on the return.

With all of this, there was so many places to let the cold in that I warned Mr. Curly, the superintendent, that we would have trouble; but he said that he could get nothing done about it and it was now settled that the concrete work should stop for the winter.

We had a very heavy snowstorm the day after Christmas and then it came off very cold, so that one morning when we attempted to start up, we first found that the circulating water would not run into the cylinders and the air lines were frozen and the oil was too thick to run. We had an old piece of hose there, which we connected to the heating system and used to thaw the water pipes and then got one air pipe free so that one unit was started about 10 o'clock in the morning. The other would start and then run along slowly, just barely moving. While it was doing this I opened the valve from an air flask carrying about 700 lb. pressure on it. The effect was instantaneous, for the engine started off with a bang and began to run over speed to such an extent that I was afraid the flywheel would go; as quick as I could, I opened the drain valves from the fuel valves and she soon stopped. You see this showed that she was getting no air to inject the oil, but the pump was putting enough up there to make it go slowly. Then when some air pressure was admitted, it forced a heavy charge of oil that had passed the governor into the cylinders and nothing could stop it until the oil was burned.

As the air line from the compressors was under the ground we tried the electric method of thawing and cleared it so that we could run in the afternoon.

I will have more to tell you in the next letter, until then, I remain, Yours very truly,

WILLIAM WALLACE.

U. S. CIVIL SECVICE COMMISSION announces the postponement from June 22 to Aug. 3, of the close of receipt of applications for the nonassembled examination for senior architect. Two vacancies in the Interstate Commerce Commission under the act providing for the valuation of the property of common carriers, for duty in the Central District, and vacancies in positions requiring similar qualifications throughout the United States, at entrance salaries ranging from $2100 to $2700 a year, will be filled from this examination. Applicants must have reached their twenty-fifth but not their fiftieth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312.

"NEVER FIND your delight in another's misfortune."

Freak Air Compressor Cards

SOME TIME AGO, on taking charge of a small light and water plant, I found the air compressor—compound—pounding very badly, and the firemen complaining of the amount of steam it took. I was puzzled to account for the heavy steam consumption, as the machine was running with a light load. I did not have my indicator with me, but sent for it and, in the meantime, prepared piping for its connection to both steam and air cylinders. As soon as it came, I took cards from the low-pressure side, at it appeared to be laboring the more, and, with the exception of a very little cutoff and a rather high initial pressure, found everything in good shape. I then took the high-pressure steam end and the accompanying card

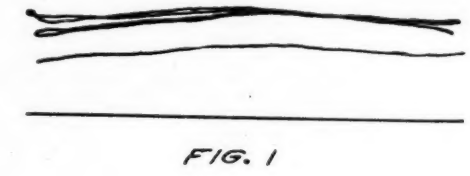


FIG. 1

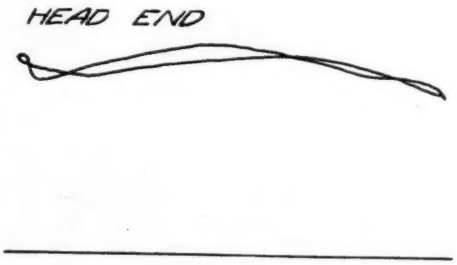


FIG. 2

FREAK CARDS TAKEN FROM AIR COMPRESSOR

is what I got. At first I thought there must be something wrong with the indicator, so examined it thoroughly, changed springs and tried again, with the same results. I immediately took off the valve chest cover, removed the valves, which were not displaced in any way, and on thorough examination found that the seat was nearly ⅛ in. high in the middle with the valve merely sliding back and forth on the high point. The steam was passing around to the low-pressure side, so the waste of steam and the laboring condition of the low-pressure side were easily accounted for. Since it was necessary to keep this machine on continuously, if possible, I had pipe cut and fitted to go from throttle to low-pressure side, removed the cylinder as quickly as possible, sent it to the machine shop to have the seat refaced and ran on low-pressure side until it came back. After it was replaced, I ran on high-pressure side until I could have a new pin put in the crosshead. The valves on each cylinder were set at ¼-in. cutoff, and I have had no more trouble with the compressor.

D. H. HULL.

Thoughts Inspired by May 1 Issue

WHILE IN a general way I have graduated out of the powerhouse into the mechanical engineering field in a small way, yet I keep posted on the engineering game through your magazine as a matter of duty. We have a large number of engines here that occasionally go democratic and they need attention and that P.D.Q.

Keeping the wheels going in a plant the size of this is not the summer day's vacation at the beach that it looks to be, with its 14 elevators, 24 cranes, which require approximately 4½ miles of cable, and 215 motors scattered over 56 acres operating machines of all kinds, to say nothing of the miles of shafting, hundreds of countershafts, and a variety of machine tools, punches, hydraulic presses and steam hammers that includes a sample about everything that is built.

There is just one word in this plant that must stand out, after every other spoken or written word has passed on to oblivion, and that is the word PRODUCTION. Forget that word and the ax comes swishing through the air.

You Chief Engineers down there—you swivel chair firemen, as it were—have the happy faculty of knowing just what the readers want and what they ought to know. You keep abreast of the times and also enough ahead to inspire the readers to better things. The achievements of the recent past, the present days' progress, and the hopes of the future are displayed in about the right quantity and in a short and concise manner—no verbal foliage—no glittering generalities with the crucial point eclipsed.

Take for instance the article in May 1 issue headed "Plan the Job," by J. S. Carpenter. Here is where many men fall down, not through lack of industry, but through lack of thought. I have seen a "boss millwright" who could not figure pulley speeds, put up a lot of shafting with motor drive and a number of machines, who would "cut and fit" until the desired result was obtained—if the supply of belting and pulleys lasted long enough.

Just before I started this letter, I finished a drawing for a layout of machinery in one of our plants in another city. (I am not saying this for personal reasons, but to show how this kind of a job ought to be done.) Every piece of machinery, shafting, counter, motorstand

and motor was definitely located, showing sizes of shafting, size of pulleys, width of belts and speeds of machines, and when the men go up there to set up the job, they take a blueprint and follow it thoroughly—and it will run.

Separate drawings show details of steel motorstands and a day or two spent in perfecting a comprehensive plan saves days of time (and time is money), besides utter confusion that will otherwise ensue. Planning the job is the first step—and a long one—towards a successful job.

Under "planning the job" might also be classed what we term foresight. Much hard work and delay can be eliminated by keeping a watchful eye on machinery, and a co-operation with the numberless foremen will simplify matters to a wonderful degree. Oh, sure, a breakdown will occur in spite of the greatest vigilance, but even here a careful inspection of the "wreck" and a well defined plan outlined will expedite matters wonderfully. When the "gang" has a good well thought out plan of action explained to them, and all of them working to a common end, the worst wreck is back on the job in a surprisingly short time; but if the gang has to "go it blind," they lack confidence with the resulting lack of interest which delays matters. Getting the wheels going again, a little before "the old man" expects, is a lot better than having him come around and say, "whyinell haven't you got this damn thing going?"

No book or magazine can tell exactly how to do or not to do anything. (Right here I was interrupted by a large gear on a punch press that bit off more than it could chew and has to go to the dentist and get its teeth fixed.) But to continue. At best, book or magazine knowledge is seldom definite, but merely points out the road to be followed, leaving the question of details to the resourcefulness of the one in charge who must engineer his way through according to the difficulties encountered.

Your editorial, "The Value of Management," is a subject that deserves, and should receive by your readers, more than passing notice. It should be studied by men wherever employed in industries, from president to helper.

Were I to dwell on the excellence of your reading pages, I could touch on every single item. They all seem to be the right thing in the right place. "Personality," by Jack Ball, sums up a lot of things in a few words. After all is said and done personality is something you don't get out of a book—it is born with you—it is the first thing you own. So many people fail miserably by trying to copy the personality of some one else rather than by developing and improving their own.

Studying human nature is a science. One must learn it to meet with any degree of success. Fair treatment and words of encouragement will accomplish more than all the bullying in the world. If everybody is boss, nobody is boss. Let the man under you know that you are the only one they must look to for orders and what you say takes precedence over every kind of petty interference. They soon learn to tell the annoying ones, "better tell that to my boss," and you soon build up an efficient crew. If a man makes a mistake in judgment, point out his error, but don't "bawl him out" before the crowd just because you happen to be in authority. If he is not susceptible to training, he is not the man for your gang; one disgruntled grouch or dissatisfied man will do more to break up a smooth working organization and cause you more trouble than an entire green crew. I find that a few words of honest encouragement accomplish wonders and instill confidence in a man. The farther you can get a man away from the "oh, what's the use" idea, the better man he is.

Sparks from the advertising pages is always read diligently for it contains much food for thought. It is a sort of golden text gleaned from the actual pages of advertisements. And this brings me to your chief source of revenue — the ads. Personally I read most of the ads. Not that I propose to buy the goods thus displayed, but because it is a source of knowledge, and knowledge is power, notwithstanding the calamity howler who goes about with sour visage and growls, "The more you know the less you get; looket me f'rinstance!"

Well, here I am on page 7 and only intended to write a cablegram.

GEORGE H. WALLACE.

Two Lathe Grinding Attachments

THE ACCOMPANYING illustrations show two useful lathe attachments, which can be built at little or no expense.

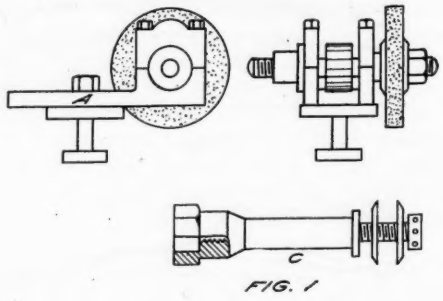


FIG. 1

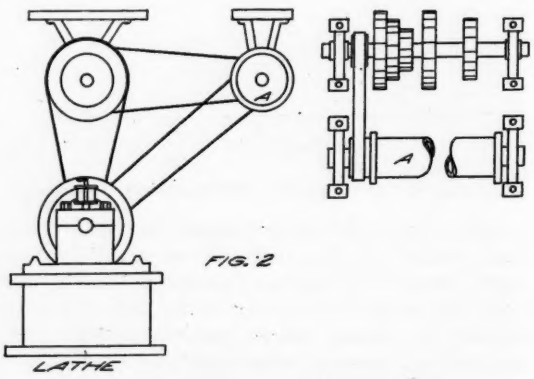


FIG. 2

FIG. 1. A HANDY GRINDING HEAD
FIG. 2. METHOD OF DRIVING GRINDING HEAD

The grinding head shown in Fig. 1 is designed to be clamped onto the slide rest of the lathe in place of the tool post, by means of the shank A. The body of this attachment may be so proportioned that by turning the whole upside down, the spindle is brought in line with the lathe centers for internal grinding. An extra arbor, as shown at C, is necessary for this kind of work.

The grinding head is belt-driven from an auxiliary countershaft, A, Fig. 2, carrying a drum and a pulley, which is, in turn, driven from the main lathe countershaft. The drum is made of a piece of 4-in. pipe, bushed at each end. Journals are provided at each end and the whole is mounted in the lathe and trued up. The length of this drum should be equal to the maximum distance between lathe centers. The diameter of the pulleys on the drum shaft and the grinding head should be such as will give the wheel a speed of from 1800 to 2600 r.p.m.

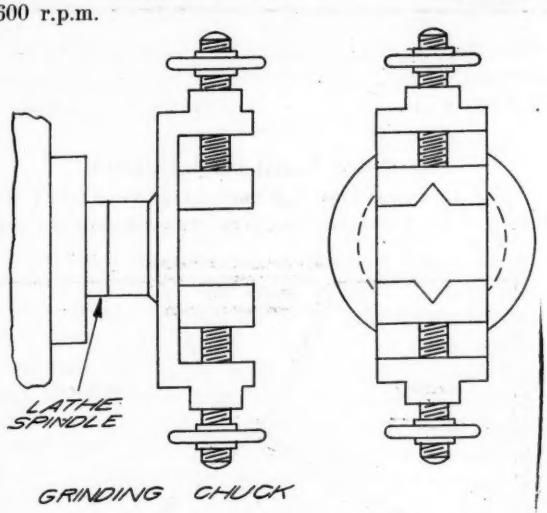


FIG. 3. A USEFUL VISE CHUCK

Figure 3 shows an adjustable vise chuck, designed to screw onto the lathe spindle, which is handy for holding small, flat pieces for grinding.

OTTO DORTHEN.

A Mean Trick

THE MEANEST trick I ever heard of was done in a certain plant where the chief engineer had been discharged. Coming in to start up the feed pump on Monday morning, the new chief heard a peculiar sound in the pipes as the valve was opened. Taking down the pipes, he found a lot of rivets and nails. Suspicious, he proceeded to examine the boiler that was not in service and found a bushel of scale on the front sheet. This work had apparently been done on Sunday when the plant was down.

JOHN L. COOPER.

Power Transmission Troubles

NOT LONG ago the writer was installing a machine which had to be in running order by Monday morning, while the installation was to be done on a Sunday. In getting ready for the job, I instructed one of the helpers to see if there was a pulley of the proper size in stock and he reported that there was. The day after the machine was in place and when about ready to place the pulley on the line shaft, I noticed that the face of the pulley was not wide enough. As there was none in stock of the proper size and as it was Sunday I was up against it for a while and it was impossible to obtain a new pulley that day.

In looking over the stock I found another pulley of the same size as the one we had, so the two pulleys were placed side by side on the shaft. They were of the split wood type and used for a driving a machine on which the belt was shafted from loose to tight pulley and vice versa.

In another instance, when a number of wash machines in a laundry plant were in place, I instructed one of the helpers how to place the split wood pulleys on the line shaft. I paid no more attention to this matter

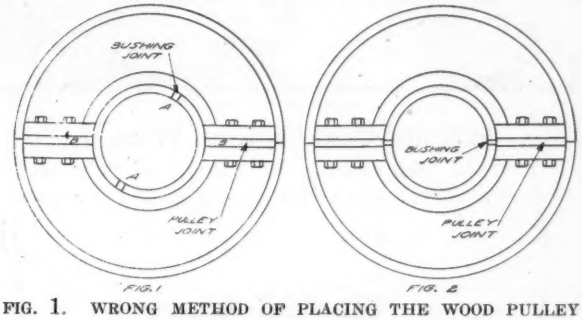


FIG. 1. WRONG METHOD OF PLACING THE WOOD PULLEY BUSHINGS

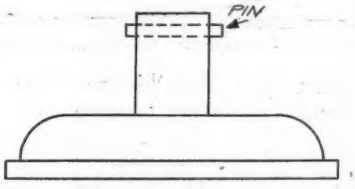
FIG. 2. CORRECT METHOD, WHICH PREVENTS SLIPPING

until all was ready to run. A few hours after some of the pulleys started to slip on the shaft. At first I thought the bolts were not sufficiently tightened on the pulleys, but found that in most of the pulleys the bushings were placed wrong. As shown in Fig. 1, it will be noticed that the bushings joints A A were opposite the pulley joints B B. This, of course, would not allow the bushing on the shaft to be compressed when drawing up on the pulley bolts. The bushings were changed to the position shown in Fig. 2.

H. A. JAHNKE.

Vacuum Pump Repairs

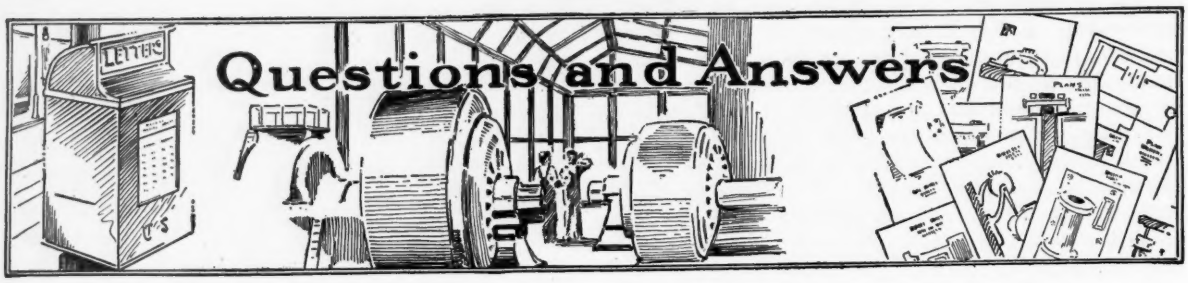
I HAVE a Warren vacuum pump with the Knowles valve gear. This pump was running very poorly, due to its worn-out parts; but as I was unable to get a new one last summer, I sent for some new parts. There



HOW PIN WAS USED TO TAKE UP END MOTION

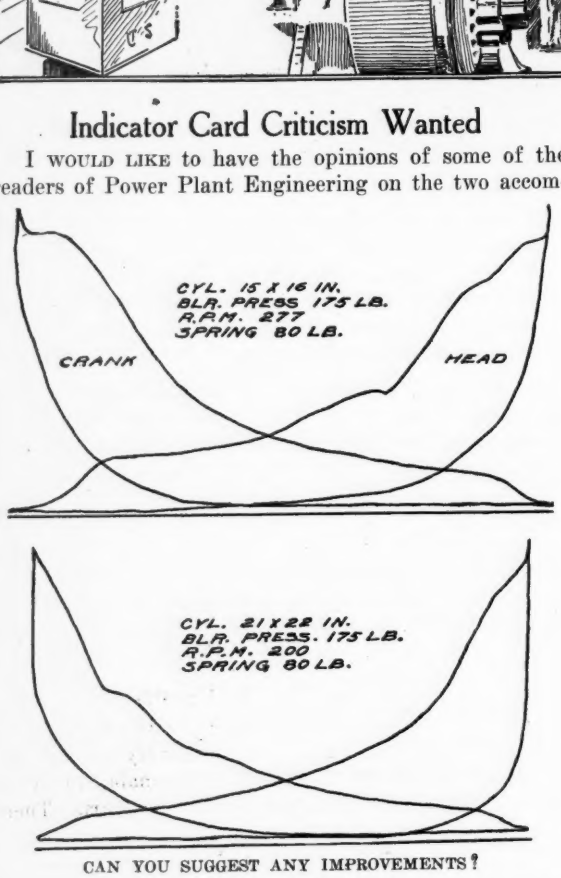
was so much lost motion in the old parts, however, that even after adjusting the roller as high as possible, it would not move the rocker arm enough. I then fastened some ⅛-in. strips under the rocker near the end. This helped, but in order to get the pump to run fairly well, I had to put washers on the valve rod, so that the crosshead arm would strike the washers and move the chest piston and operate the main valve on the head end. The other end was operated by the adjusting link. Still, at times, it would stick on one end and, on taking the chest piston out, I found there was 3/32 in. lost motion between the valve stud and chest piston. I then drilled through the valve stud, put in a pin as shown in the illustration, and filed ends until they just cleared the chest piston. This pump has been running for some time since then, and I have no trouble with it sticking on either end.

W. N. L.



Indicator Card Criticism Wanted

I WOULD LIKE to have the opinions of some of the readers of Power Plant Engineering on the two accompanying cards, taken from Skinner Universal Unaflow engines. Both engines are running well.



CAN YOU SUGGEST ANY IMPROVEMENTS?

A. E. T.

Recovering Exciter Magnetism

IN LOOKING over the June 15 issue of your paper, I notice an article by H. E. S. in reference to an exciter losing its magnetism.

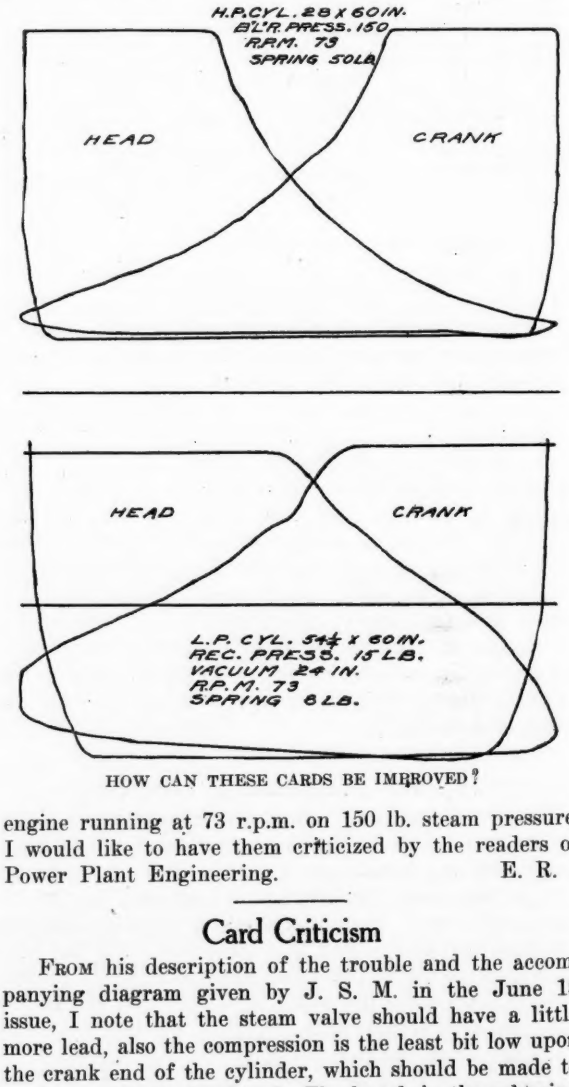
We had a similar experience at my plant on a 400-kw. generator. In order to start up, it was nearly always necessary to turn the juice on from our emergency set in order to get under way again, until two weeks ago she quit for good. Apparently all efforts to recharge were useless. The only thing we did do was to create a very heavy ground that did not exist before, so after the usual game of checkers in the way of disconnect, then test, until we had disconnected everything including every field coil, we found our ground; also our lost magnetism. One of the leads to one of the shunt coils had broken the solder and had burned away until it charred the fiber insulation.

After cleaning away the burnt fiber and substituting new and making a new perfect solder joint between the end of field wire and terminal, we were ready to reconnect and try out. Then all our lost magnetism returned as if by magic.

H. ARTHUR VAN FOSSEN.

Indicator Card for Criticism

THE ACCOMPANYING indicator cards were taken from a 28 by 54¼ by 60-in. Nordberg cross-compound Corliss engine running at 73 r.p.m. on 150 lb. steam pressure. I would like to have them criticized by the readers of Power Plant Engineering.



HOW CAN THESE CARDS BE IMPROVED?

E. R.

Card Criticism

FROM his description of the trouble and the accompanying diagram given by J. S. M. in the June 15 issue, I note that the steam valve should have a little more lead, also the compression is the least bit low upon the crank end of the cylinder, which should be made to conform with the head end. The knock in the releasing gear is probably caused from some undue friction in some of the working parts of the valve gear. The steel washer between the valve and the bonnet which is around

the stem may possibly be worn untrue, and during certain motions of the valve produce friction on the packing around the stem possibly if metallic should be replaced with new packing, as trouble quite often comes from that source. Connecting rod pins should be turned around occasionally as the bearings working in the same position upon the pins will form flat sides, and unless the slack is taken out of the bearings and they are in motion have a tendency to wedge themselves which will cause a knock. It is important to observe that the valve itself is perfectly free and also that the back bonnets have enough packing between them and their face upon the cylinder that the valve is not binding upon its ends, and also that it has not too much play.

H. W. Rose.

Dashpot Trouble

I have just been reading R. N. D.'s letter in June 1 number requesting solution of dashpot trouble. My experience has been that most dashpot troubles are located outside of the dashpot; after reading his article, I am inclined to think that this is another such case.

Both cylinders of the cross-compound engines I am operating are equipped with hand oil pumps in addition to the automatic lubricator driven from valve gear. This hand pump is used in starting up and if it is needed after a few minutes' run, we look for something wrong if the lubricator is working O. K.

On one occasion, a hole was found chafed in the long pipe leading to the high-pressure cylinder, resulting in our generous feed of cylinder oil being distributed on the basement floor instead of in the cylinder.

One of the engines took an unusual amount of oil for some time after starting up. We examined the steam valves after shutting down and again after standing 24 hr. and found that a leaky throttle had washed all the oil off the valves.

At one time, we had trouble in getting our lubricator to force the oil into the high-pressure cylinder and found the ⅛-in. pipe that projects into the steam pipe carbonized solid full. When we pull a steam valve out to examine it, we also see whether it has end play enough; sometimes a thicker or double gasket under the bonnet has cured the trouble. If the valve stem is worn so that the T-head digs into the bonnet, that will cause trouble that can be remedied by a loose collar on the valve stem inside of the bonnet or a thrust collar outside, held in place by setscrews. An old valve will sometimes wear shoulders in its seat that will cause trouble if a change in the valve travel is made.

Valve-stem packing pulled up too hard, or unevenly, or old packing will bind the stem. On one occasion a dashpot rod was found to be sprung, causing the dashpot to bind. A dashpot would have to be in better shape to operate satisfactorily at this slow speed than it would at a higher speed, as any leak in the vacuum chamber would have so much more time to admit air.

On dashpots using cup leathers, we sometimes take them out, soak them in neatsfoot oil and soften them up by working with the hands. A piece of canvas put under the leather will build them up and make them fit tighter. Some dashpots have seal rings or grooves turned in the plunger that may need cleaning out. If there is a valve or checkvalve connected to vacuum chamber, it should be tight.

In connection with valve troubles, I want to speak of something that happened on a vertical pumping engine that was run only about one day a month to keep it in shape. On two occasions, upon starting up the high-pressure head-end exhaust stem was twisted so that we could not run. Whenever we laid this engine up after its day a month run, all steam and exhaust valves were pulled out and valves and chambers swabbed with cylinder oil and graphite. On the day before the next run, we examined the valve again, so we knew the lubrication was O. K.

The cylinders had steam jackets fitted with air vents and the fireman on nights would put the jacket steam on about 4 a. m. and was supposed to leave the vents open to drive out all the air. It was found that one vent was not opened, leaving this part of the cylinder cold and when the steam passing through the exhaust valve expanded it faster than the chamber around it expanded, the valve would grip in the chamber, causing twisted stem. This could not occur with a steam valve, due to difference in construction.

The slam in the low-pressure cylinder may be due to valves being thrown from seat on account of lower receiver pressure or higher back pressure in starting. An indicator might show what it was.

John A. Murdock.

Grates Burn; Eliminating Condenser

In reference to Richard A. Carl's letter in the April 15 issue, I would say that it is quite easily seen that the whole trouble lies in the arch, and I believe that the only satisfactory remedy would be at least to double the present height of this arch; no doubt this would involve considerable expense. I would suggest that the arch be well ventilated, and that steam be introduced beneath the grates. Any advantage gained by moving baffle tile to the second row of tubes will be offset by substituting the lower row of tubes to the direct flames.

George R. Coste.

The article by Richard A. Carl on page 446, Apr. 15 issue, and that on the same subject by H. W. Rose on page 630, June 15 issue, have arrested my attention.

The great trouble with grates burning out in any kind of a furnace is that not enough air is admitted below the grate to keep it cool.

I have had grates burn out in hand-fired boilers doing 50 per cent rating for 10 hr. and then banked, that never burned out when they were pushed to 150 per cent for 24 hr.

When they were banked at night and the ash pit doors closed, the trouble started; the grate bars overheated and warped or burned out.

I have had large stoker-fired boilers that never showed signs of grate trouble when fires were pushed 24 hr., but parts burned out when night load was very light and wind was shut off. In a hand-fired boiler furnace, the grates burn out if the ash pit is allowed to fill with ash and if clinker is allowed to accumulate on the grate and shut the air supply off.

Then the reflex action takes place and the above-mentioned condition obtains.

If we knew at just what stage of the combustion the grate clips began to show distress, of course the ash theory might be proven.

If the nut coal is all burned out before reaching say, one foot of the dump position and the ash shuts off the air of the grate, the grate is no doubt melting at this point.

If Mr. Carl can control the air and put more through the grate at this point, no doubt he can save the clips to a big extent.

I have operated Heine boilers that were doing 150 per cent rating, stoker fired, a good grade of soft coal being used, and the uptake temperature was less than 600 deg. F.

I would put the baffle as Mr. Carl suggests, as it has proven to be the proper remedy in many cases.

I wish we might know the draft reading at different points in his setting and also the temperatures at same points.

J. Raia's query, "Can We Eliminate the Condenser?" on page 447, April 15 issue, seems to me like "The Arabian Nights," or perpetual motion.

The statement that the 55 per cent of heat that is now lost may possibly be saved is like saying that some day the engine will not lose the heat that is put into it in the form of steam, and then we will be up against the problem of trying to stop it from melting (the engine). We learn that heat is work and vice versa.

The work of putting the exhaust steam back against boiler pressure means work and work means sacrifice of heat, therefore it would seem that this problem would hardly be accomplished.

The best way, up to date, to get the heat units from the exhaust seems to be to turn it in a tank of water and use the water—that saves coal.

TOM THUMB.

Metallic Packing; Smokeless Firing; Lubrication

IN ANSWER to Tom Jones' question in the June 15 issue as to whether it is good policy to use cylinder oil on the piston-rod packing, I would say that I think it is, and on engines with soft or fibrous packing especially. I have seen engines that could not be run without a little cylinder oil on the rod. It is not necessary to put enough on to rot the packing. It will prolong the life of both the rod and packing.

I would suggest that A. R. K. change his method of firing and I think it will help solve his smoke problem. He says he has natural draft enough without the blower and that when the steam drops 5 lb. the blower starts up and the firemen throw on fresh coal; I would take it in large amounts. Now if instead of waiting until the steam drops 5 lb, he would have his firemen try to keep the steam at 110 lb. steady and fire the fresh charges of coal in small quantities and at more frequent intervals, I think he would have less trouble with smoke.

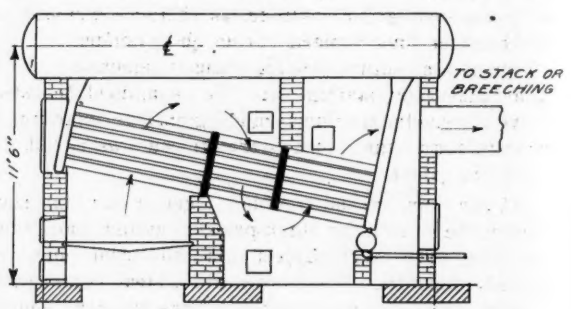
The letter of Frank L. Wadsworth about the amount of oil used in the article by W. F. Schaphorst interests me. I think that Mr. Schaphorst is right and that 15 gal. of oil per hour is not too much for a 550-hp. engine in stationary practice. Of course, I don't know anything about ship practice. This, of course, refers to plants with a continual oiling system where the oil goes to the bearings, passing off through a filter and finally back to service tank to be fed over again. D. G. S.

IN THE ISSUE of June 15, Tom Jones asks whether it is desirable to place metallic packing on a new piston rod. I have had considerable experience in placing metallic packing on high and low-pressure steam engines and ice machines, with new and old piston rods, and I have never had the slightest trouble from this packing on a new rod. In placing the style of packing he speaks of, the rod should be in perfect alinement with the stuffing-box. In most cases, there will be a slight leakage for a short time, until the rod and packing come to a bearing. I have never found a new rod scratched or scored after being run if properly lubricated.

In regard to soft packing taking care of small particles that may have been left in the steam ports or cylinder, I will say that before closing up the steam chest or cylinder after doing repairs or erecting an engine, these parts should be thoroughly cleaned by blowing with steam or air.

It is advisable to lubricate the piston rod from an oil cup placed on the top side of the cradle so the oil will drop about 3 in. from the face of the gland. With a heavy oil and the proper adjustment of the feed, the packing will last a great deal longer, and will keep the rod from scoring. C. J. MILLER.

IN THE June 15 issue A. R. K. asks some of the readers to suggest a cure for smoky furnaces. The accompanying sketch shows a setting, which I have used successfully in connection with 150-hp. B. & W. boilers. With this arrangement the boilers will not smoke.



SMOKELESS SETTING FOR B. & W. BOILER

HARRY RICE.

IN THE June 15 issue Tom Jones asks some questions relative to the use of metallic packing on new rods. My experience with this form of packing has been very satisfactory. I have used it on new rods and when at first applied, the case is well filled with cylinder oil and flake graphite in all spaces around the rings, making sure that there are no particles of hard matter, as filings or chips, in the case or around the rings. No trouble whatever has resulted from the use of this packing on any new rod. The rods take on a bright and particularly smooth finish after being in operation for a short time; in every case, however, care must be taken to see that the rods are perfectly true and that they travel in

perfect line with bore of cylinders and crosshead guides and, should the necessity arise to remove the packing from the box and case, the rings must be replaced in the same order as removed. In a three-ring case, at times the rings will work better if put in 3, 2, 1 order instead of the reverse. I have at present two Unaflow engines operating at 275 r.p.m. with 130 lb. pressure and this packing has not been out of the boxes since I installed the engines in 1915 and has given perfect satisfaction.

I was very much interested in Frank L. Wadsworth's remarks relative to the proper amount of lubricant an engine should get. Of course, conditions will govern this to a greater or less extent; but I agree that 15 gal. of oil an hour seems a little unusual unless the engine in question is equipped with an oiling system through which 15 gal. of oil is pumped every hour, using the same oil over again through a filter. In this plant, which is operated 5 mo. of the year and in which the above-mentioned Unaflow engines are installed, we use one barrel of lubricating oil every three seasons; that means one barrel every 15 mo. of operation and after the oil has been in the oiling systems on the engines for six weeks it is put through a filter and used on pumps, elevator, steam roller, dishwashers and laundry shafting and other machinery. In this filter are also put all drippings from lubricators. We have 21 cylinders to lubricate ranging in size from 3½ to 14 in. and use for these 60 gal. of 600 w. per month. Some of our steam is carried 500 ft. to pumps, etc.

I find the application of cylinder oil to the rods where soft packing is used to be of value and I usually apply this mixed with graphite, very little being required and is especially beneficial when used on rods which stand idle for long periods of time.

I would like to see some comments on the Unaflow engines from those who have had experience with them.

CHAS. L. RIECKE.

IT WILL be found of advantage to use some good soft packing until the rod gets a good glaze, then to install metallic packing. There is no definite time to use the soft packing. After the soft packing is installed, keep it lubricated with a mixture of boiler graphite and cylinder oil. At the present time, I am using soft packing, and can say from experience that a dash of cylinder oil on the rod once in a while certainly prolongs the life of the packing by keeping it soft and pliable. I have heard engineers complain about their soft packing either blowing out or burning. This is my method of installing: Being sure that there is no old packing in the stuffing box I put new packing in, taking care to break joints, tighten up just enough to be sure it is all together and then slack off again. I tighten up the nuts as tight as I can get them with my hands, being sure that the gland is equally divided around the rod. Every time after I stop the engine and before I start I try the nuts to keep them tight and I find the packing will not burn, neither will it blow, except when badly worn out. After the gland is in far enough I add another ring as a "filler."

W. A. SMITH.

I WOULD suggest that Tom Jones place the new metallic packing upon the new rod, and allow both rod and packing to adjust themselves, although it would be good practice to allow cylinder oil to drop upon the rod from an oil cup, which would assist the forming of the glazed surface upon both the rod and the packing. In reference to the lubrication problem, I would state that where conditions are normal and the cylinder is properly lubricated, it would not be necessary continually to feed oil on the rod from a drip cup.

H. W. ROSE.

Mss. No. 1018

IN REFERENCE to A. R. K.'s letter of June 15, the accompanying illustrations will probably solve his trouble as they did mine. The baffling walls are built of fire-

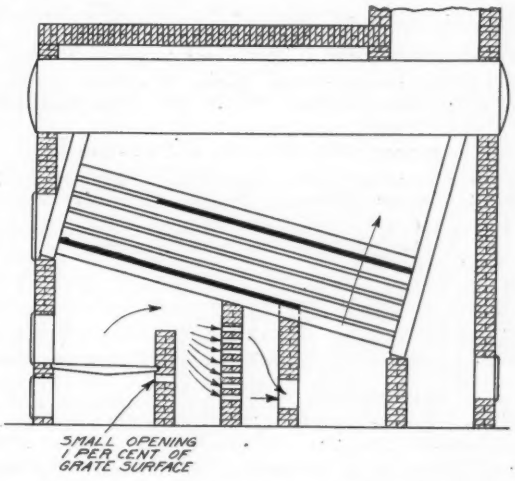


FIG. 1. SHOWING LOCATION OF BRICK CHECKERWORK

brick as shown, taking care not to reduce the area of the smoke passages. The main feature is to keep the smoke hot enough for it to burn itself with the air that passes in from under the grate through the bridge wall, dispensing with the steam under the grate, as the moisture

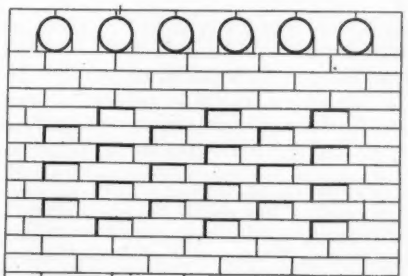


FIG. 2. SHOWING ARRANGEMENT OF FIREBRICK

has a tendency to cool the gases. Figure 1 gives an idea of the location of the firewalls and Fig. 2 of the best porous formation for such a wall.

H. A. VAN FOSSEN.

U. S. CIVIL SERVICE COMMISSION announces an examination, July 27, for engineer of tests, to fill a vacancy in the U. S. Naval Ordnance Plant, South Charleston, W. Va., at $8.80 a day, and vacancies in positions requiring similar qualifications, at this or higher or lower rates. Competitors will be rated on education, experience and fitness. Apply for Form 1312.

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Federated American Engineering Societies

Formation of this organization as reported in the last issue of Power Plant Engineering becomes a long forward step toward the placing of engineers in their rightful prominent position in public affairs. The objects of the organization are "To further the public welfare where technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions."

Heretofore work of this nature has been done by individual engineers or by individual societies. It is a well proved fact that legislative bodies, committees and commissions pay little attention to the statements or opinions of individuals or representatives of small groups; but delegates representing the best thought of the entire engineering profession (and incidentally the voting power included in a large federation), will be certain of respectful hearing and careful consideration of their arguments.

The benefits to an engineer of membership in his local or professional society have been unquestioned, but the opportunity to be of service through activity and representation in this larger federated organization will be an added incentive and reason for organization membership and becomes a part of his public duty. Representative engineers in the governing bodies of cities, states and the Nation should become the rule rather than, as at present, the exception. The importance to the public of the work of engineers has come to be recognized through the part taken by them in the great war; and it only remains for the same spirit of public service, initiative and effective administration to be maintained in order to have engineers take their proper place with lawyers, professors and business men in the legislative and administrative activities of the country.

Success of this movement, as of all others, depends on numbers and activity. It should be the desire as well as the duty of every engineer to back up this larger movement for advancement of engineers by joining the organization which he prefers, by working to have that organization join the Federated American Engineering Societies, and by insisting that the delegates sent to the American Engineering Council are men of ability who will properly represent his organization, will add to the prestige of engineers in the eyes of the public, and will actively work for the public welfare and the interests of the engineering profession.

Color Schemes for Bus Bars

In many power stations, particularly those of small and medium capacity, no means are, as a rule, provided to identify bus bars, thus frequently jeopardizing the safety and lives of all having aught to do with this part of the equipment. Where both low-voltage exciter and high-tension alternating-current bus bars are carried mounted at the rear of the same board, an operator obliged to make some minor repair or adjustment to some piece of apparatus, may carelessly or unknowingly come in contact with a bar he believes to be of low voltage, but which, in fact, is one of two or more carrying current at a comparatively high voltage. The result

is obvious. The man, if not killed outright, is bound to sustain serious and perhaps permanent injuries.

Already power plant engineers have adopted color schemes for piping. Means are thus provided to enable the operator to identify at once the service rendered by and function of each particular length of pipe and to prevent the manipulation of any valve which might not only seriously affect operation, but also subject equipment and employes to danger.

If, therefore, it is desirable in some manner to provide means for the identification of piping, it appears not only desirable but absolutely necessary to utilize a similar scheme in connection with the deadly bus bar. Such a scheme need in no way be elaborate or complex. Means for distinguishing the high-voltage bars from those of low voltage could be accomplished by painting the former a bright red and the low-voltage bus bars some other color, as, for instance, green; and where, as in some plants, high voltages of different values exist, red might be employed on the bars of higher tension, yellow for the others and, as before, green for the exciter system bars.

Not only would operation and repair work be greatly simplified, but, what is of greater import, the dangers attendant on the work of the station employes would be materially lessened. If, then, for no other reason than the sake of safety, let us adopt color schemes for bus bars.

Off Duty

———but what about the future? That's the big question.

"What future?" we ask.

"Our future source of power when our coal is exhausted."

"Oh! well, we should worry."

And that's just it, we should worry—or, at least it won't do us any harm to spend a little time cogitating about it. Just because we are lucky enough to have had a set of conservative ancestors who were easy on the coal pile is no reason why we should exhaust it without regard for future generations.

In a number of thousand years, four or five—it doesn't matter, the geologists inform us, unless we let up on our present rate of coal consumption, we shall find ourselves out of a job. When the last shovelful of coal has been fired into the furnace, then—well, let's hope that we won't be shoveling coal at that time.

Water power, they tell us, won't supply our needs, and wind power or wave power doesn't seem very practical. Then what! Sun power? Inter-atomic energy? The latter, the scientists tell us, may help us out of the difficulty.

Inter-atomic energy! Sounds mighty highbrow and we seem to recall hearing it used in connection with radium. Let's go into it a bit deeper.

It has been discovered that some of our well-known elements are automatically going to pieces, and others are having decomposition thrust upon them. The first proof of this atomic disintegration was the radical discovery that radium was a new, uncontrollable and dangerous element which was shooting itself to pieces. In other words, radium is steadily, by a series of explosions as it were, throwing off small particles of matter at tremendous velocities (60,000 mi. per sec.), and the curious part of this action is that it is not dependent upon any external conditions. Neither heat nor cold nor chemical action have anything to do with it. It is due to a force within the atom of radium itself—that is why we call it inter-atomic energy.

These small particles (called Alpha particles) which are thus projected from the radium atom, are found to be entirely different from the radium itself—they are atoms of helium, not radium at all. In fact, here we have the old dream of the alchemists come true—one element changing into another.

Now, radium is not the only element which possesses this peculiar property—certain others exhibit it also to a lesser degree, and it seems that as these small particles are emitted, the original element changes successively into different elements. Uranium, for instance, passes through eight different stages and finally, it is believed, transforms into lead.

This process, the transition from uranium to lead, takes millions of years. Suppose we could, by some means, enormously increase the rate at which this change takes place. Instead of millions of years, suppose it took place in one second. The combined energy of the millions of particles through the millions of years would then be concentrated in the short space of one second and if one gram, or 15 grains, of uranium were changed into lead in this short time, the rate at which work would be done would be 25,000,000 hp.!

While this spontaneous disintegration of atoms is only a property of what we know as the radio-active elements, we must believe that all elements contain equal amounts of energy in their atoms. Thus, if instead of utilizing the chemical energy in coal, we could utilize the atomic energy, one pound of coal would produce 11,325,000,000 hp.-sec. or 3,115,000 hp.-hr. At this rate, the plant's annual fuel supply will probably be kept in a cigar box.

This is what radium has taught us. How could it happen that, with our countless tons of old, reliable, available elements, we should have to get the greatest lesson from an element of which the whole world hardly contained enough for a necessary atomic weight determination? (There are only 110 grams in existence today.) The answer, as usual, lies in quantitative measurements. The idea that the atom of one element became the atom of another by losing helium and negative electrons had to be accepted as a measured fact.

It is the province of science to discover the laws of nature and it is the province of engineering to apply them. It is to the engineers of the future that we leave the problem of making use of this tremendous store of energy concealed in the atoms of all matter.

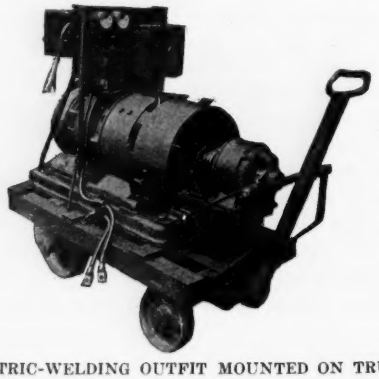
SPECIFICATIONS for the roadbed to success: Dig deep into the knowledge of the history, progress and present practices of your chosen profession; lay a heavy foundation of hard work mixed with a generous supply of midnight oil and self denial, tamp this mixture until it becomes solid and will remain so; wet this surface with a few tears as a binder to the next course, consisting of associations with fellow men and professional investigations cemented together with the milk of human kindness; finish the surface with a thin coating of idealism, initiative and determination, worked to a polish with the fire of ambition to surpass all in service to mankind.

Single-Operator Electric-Welding Outfit

THE single-operator electric arc-welding equipment shown herewith is claimed to be exceptionally efficient because the generator operates at arc voltage and no resistance is used in circuit with the arc. The generator is designed inherently to stabilize the arc, thereby eliminating the necessity for providing automatic moving devices such as relays, solenoid control resistors, etc., which not only increase the cost of investment and maintenance, but may not be quick enough in action to follow the instantaneous changes of the arc circuit.

The generator of the set has a rated capacity of 175 amp., and is provided with commutating poles and an exceptionally long commutator which enables it to carry the momentary overload at the instant of striking the arc without special overload protection.

Design of the control is such that very close adjustment of current may be easily and quickly made, and once made, the amount of current at the weld will remain fixed within close limits until changed by the operator. There are 21 steps provided from 50 to 225 amp. This gives a current regulation of less than 9 amp. per step which makes it much easier for a welder to do vertical or overhead work often encountered in railroad shops and ship construction.



ELECTRIC-WELDING OUTFIT MOUNTED ON TRUCK

The generator is mounted on a common shaft and bedplate with the motor. A pedestal bearing is supplied on the commutator end which carries a bracket for supporting the exciter which is coupled to the common shaft of the set by means of a special coupling. Motors can be supplied for either direct or alternating current circuits. Where an alternating-current motor is used leads are brought outside the motor frame for connecting for either 220 or 440-v. circuits.

Where the equipment is required for portable service, the motor generator set with the control panel is mounted on a fabricated steel truck, equipped with roller bearing wheels. The portable equipment can be easily hauled about the shop or yards by one man. Suitable plugs and receptacles for three-phase, three-wire or two-phase four-wire, alternating-current motors allow the set to be quickly and conveniently connected to the supply circuit at any desirable point. Only one plug is required for the motor, but the number of receptacles required depends upon the number of points at which it is desired to do welding work. These plugs and receptacles are supplied on special order.

Control for the single-operator equipment consists of a small ebony asbestos panel, mounted upon angle-iron framework. The field rheostat for regulating the welding current, voltmeter, ammeter and two-pole knife switch are mounted upon the panel.

The generator is wound, flat compound, i.e., it delivers 60 v. at no-load and also at full-load. Special attention has been given commutation and each generator is provided with commutating poles and an exceptionally long commutator, so that heavy momentary overloads can be carried without special protection even at the striking of the arc.

In using the multiple operator equipment, each operator is provided with a separate control or outlet panel so that each may take current from the same generator without interference.

Conveyor Belt Joint Problem Solved

AN unusual problem in the handling of hot cement clinkers with a temperature of 200 deg. and over was recently solved at the plant of the Standard Cement Co., Leeds, Ala., in an interesting manner.

The method decided upon for moving the clinker was a rubber conveyor belt, but the clinker could not be cooled sufficiently in the process previous to conveying to prevent scorching of the belt and its rapid destruction. The answer to this problem was found by running the belt at an incline of 12 deg., so that the lower pulley dipped into a trough of water, thus carrying a film of cold water upon the belt, onto which the hot clinker from the loading hopper was deposited.

At this point a new problem was encountered; namely, how to join the belt so that the belt's full strength would be retained, and in a way which would withstand the extremes of temperature, the wear on the pulleys and the abrasion of the clinker. For this purpose patented belt fasteners were adopted, which brought the belt ends tightly together in a snug joint, and made the belt practically endless on the pulley side, so there was no opportunity for clinker ash to get into the joint and abrade the belt ends, and also because in this method of joining, no metal came in contact with the pulleys to cause wear, and a permanent joint was thus assured. Moreover, the strength of the heads of the rivets and the formation of the plates prevented destruction of belt joint through abrasion by the clinker.

In six months of operation, this conveyor has carried 61,000 tons of clinker, and the Standard Portland Cement Co. credits the saving of $300 in belt cost alone to this conveyor. The belt used was made particularly to withstand temperatures up to 200 deg., and is adapted for work on conveying jobs in mines, coking plants and cement factories where heat resistance and ability to withstand hard wear are prime requisites.

WHEN IN DOUBT, just keep on keeping on. When you have made a mistake, do not stop, but keep on. Your sanity and your safety lie in keeping on. Dwell on failure and you will land in the ditch just as sure as the novice bicycle rider unwillingly heads his wheel in the direction of his thoughts.—The Silent Partner.

Export Situation in the Orient

DESPITE much that has been said to the contrary, the outlook for substantial growth in American business interests across the Pacific is exceedingly bright This is the message brought home by D. D. Tripp, vice-president of the Pioneer Rubber Mills of San Francisco. Mr. Tripp spent 5 mo. in the Orient where he studied export conditions at first hand. The greater part of his time was spent in China and Japan although Mr. Tripp's itinerary embraced Manila also.

"The economic situation in Japan is rather unsettled although there is nothing alarming," said Mr. Tripp. "It is common knowledge that, at the outbreak of the war, Japan was exerting every effort to become an important factor in certain phases of foreign trade. The commodities in which Japan could reasonably expect to do a large business were, primarily, the same products which Germany offered in the principal world markets at lower prices than other European or American manufacturers.

"Undoubtedly the exact cause of the recent slump in Japan was an over-extension of banking credits by the smaller banks. In any event, the situation is far from grace, as, in Japan, there is a strong central control over all business. Thus, in any time of crisis, the leaders of Japan can exercise a tight rein over the financial and industrial situation of the country and ward off panic and disaster. Japan's leaders are clear-headed men possessing the absolute confidence of the business interests of their country; and they may be relied upon to renew in its entirety the economic fabric of Japan.

"The situation in China wears a more roseate aspect. There is no question that China today offers a vast, potential field for export development. China assuredly is waking up. Young China is coming forward. The industrial status of China is steadily forging to a higher plane.

"I have talked with many financiers about it. I have talked with many Americans who have been in a position to study the situation at close range. And I have talked with alert-minded Chinese business men. The concensus of opinion is this: with the stabilization of the governmental situation will come the stabilization of credits. And with this will come a greater area of productivity than anyone anticipates. At the present time Chinese credits, like some Chinese money, have a hole in them.

"This much is certain: China offers tremendous opportunities for proper development—and not a few American concerns have been quick to sense it."

Public Works Department Voted Down

A PROPOSAL that the Chamber of Commerce of the United States advocate the establishment of a government Department of Public Works failed to carry in a referendum of the Chamber's membership, the result of which was announced recently. The votes on the three propositions submitted were:

Shall a Department of Public Works be established by the national government? In favor, 826; against, 549; necessary to carry, 917.

Shall a Department of Public Works be established by a suitable modification of the existing Department of Interior, excluding therefrom the non-related bureaus and offices by change of name from the Department of Interior to the Department of Public Works? In favor, 675; against, 679.

Shall a Department of Public Works be established by creation of an entirely new department? In favor, 282; against, 992.

Out of 1250 member organizations entitled to vote upon the propositions, 477 took advantage of the opportunity to record their vote regarding a Department of Public Works. The returns discloses an especially strong sentiment against the creation of an entirely new and independent department, the vote being about four to one against it.

The referendum was taken at the instance of the Engineering Council, an organization member of the National Chamber. The proposal submitted by the Engineering Council was reduced to three main propositions by a committee of eleven.

Utility Inaugurates Employe Representation

A CO-OPERATIVE council has been created between the employes and the management of the Public Service Co. of Northern Illinois which went into effect on July 1. At a preliminary meeting of representatives elected by the employes and appointees of management, a constitution was adopted under the provisions of which a council is formed in each district consisting of approximately one elected employe delegate for each 100 employes and not more than an equal number of representatives chosen by the management. The elected and the appointed delegates must vote as units, thus a majority in each unit rules and this vote must be the vote of the unit in the council. Discrimination against any employe is not permitted because of his race, political affiliations, membership or non-membership in any labor or other organization.

As the properties of the company are scattered over considerable territory, the plan adopted provides for six territorial councils and in case any council fails to agree upon any matter the question may be referred to the chairman of the board of control of the company. Ten days are allowed the company either to propose a settlement or refer the problem directly to the general council which is composed of an employe representative from each territorial council and not more than the same number of representatives appointed by the company. Resort to outside arbitration may be had only with the consent of the representatives of both sides. The council is planned to deal with all questions of policy which may affect the employes in any way and it is hoped that the personal contact between the management and the employes will result beneficially to all concerned.

IMAGINATION IS the searchlight that will guide the individual along the paths of progress in any line of work if he will construct in actual material the pictures his imagination sees. A mind picture without the possibility of being realized is purely a day dream.

News Notes

ENGINEERING Council has in numerous ways expedited the creation of a comprehensive, representative body to perform for the engineers of America in a larger fashion, such functions as Council has performed for the past 3 yr. In line with these activities, at its regular meeting June 17, 1920, after hearing a report on the Organizing Conference, Engineering Council endorsed the plan of organization of the Federated American Engineering Societies and the American Engineering Council, adopted by the Organizing Conference of technical societies in Washington June 3 and 4, and authorized its Executive Committee to proffer and perform on the part of Council such assistance as may be practicable in completing the work of the Organizing Conference and of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council.

INAUGURATING a policy of providing within its membership organizations of groups who are specialists in their several branches of mechanical engineering, the American Society of Mechanical Engineers has just organized a professional section on fuels. Prof. L. P. Breckenridge is chairman of the Executive Committee of the Section. Prof. G. F. Gebhardt, F. R. Low, Joseph Harrington and F. F. Uehling are members of this committee. So far two sub-committees have been appointed, one on meetings and papers, and the other on information.

The section will conduct a session at the forthcoming annual meeting of the society to be held in New York, Dec. 7-10, and will discuss the topics of Fuel Resources of the World, Low Temperature Distillation of Coal and Lignite, Relative Cost of Power Production from Fuel Burned at the Mines versus Fuel Burned at Points of Power Consumption, etc.

THE 1920 ANNUAL, which is the Sixth National Exposition of Chemical Industries, returns to the Grand Central Palace in New York, where it will be given during the week of Sept. 20 to 25, inclusive. The exposition, this year, will be the largest distinctly industrial exposition ever held, and will surpass its own predecessors by one-third. The exposition will have three special sections, one, the electric furnace section, another, the fuel economy section, and the third, a materials handling section. The two latter are new sections; the first will be, as its name implies, one of electrical furnace exhibits; the fuel economy section will consist of exhibits of machinery and apparatus, furnaces, producers, stokers, and all devices for the economic utilization or more efficient combustion of fuel. The materials handling section will be a series of exhibits of machinery and equipment for the handling of material, such as conveying, transporting, elevating, and included in this will be weighing, measuring and power transmission equipment. The program for the exposition will have sessions on subjects, the phases of which will be developed in the exhibits of these latter two sections. There will be sessions on chemical engineering, for which an elaborate program is planned. Motion pictures, which will have a keen interest for technical men, will form part of the program, and there will be popular public addresses as well.

AT THE COMMENCEMENT of the University of Illinois on June 16, 1920, and at various times during the year, 162 Bachelor of Science degrees were granted to students of the College of Engineering, distributed as follows:

Architecture	18
Architectural Engineering	24
Ceramic Engineering	6
Civil Engineering	39
Electrical Engineering	31
Mechanical Engineering	31
Mining Engineering	4
Municipal and Sanitary Engineering	2
Railway Engineering	7
Total	162

In addition, the following advanced degrees in Architecture, Engineering and Physics were conferred:

Doctor of Philosophy	1
Master of Arts	4
Master of Science	7
Master of Architecture	1
Electrical Engineer	3
Mechanical Engineer	1
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AT THE RECENT commencement exercises of Villa Nova College, Villa Nova, Pa., Thomas E. Murray, vice-president of the New York Edison Co., had conferred upon him the degree of Doctor of Science in recognition of his noteworthy work in the electrical industry. He bears the unique distinction of having installed more power plant capacity than any other man, and has been granted more than 350 patents, principally for electrical inventions.

AT A RECENT MEETING of the Stoker Manufacturers' Association held at Lakewood, N. J., the following officers and Executive Committee were appointed: Sanford Riley, president; M. Alpern, vice-president; A. G. Pratt, treasurer; S. A. Armstrong and H. A. Hatton; J. G. Worker, secretary.

The committee is to meet in New York at an early date to name the standing committees of the organization for the coming year. A vote of appreciation and a round of cheers was tendered to P. A. Poppenhusen, the retiring president.

When asked for a statement after the meeting in regard to his policies for the organization during the coming year the newly elected president, R. Sanford Riley, made the following statement:

"I have always believed that the stoker business is a good one, but it has not even yet taken its proper place in the business world. I have seen it develop from a very crude business, conducted on a comparatively low plane, to a large business conducted on a much higher plane. We are getting an increasingly large percentage of able men in the business which makes it good, not only for those in the business, but also for our customers. After all, we can profit only as we serve and the service possible by our business is one of the greatest in any line of business."

J. G. Worker, secretary, told of its constructive work in stimulating the membership, which includes 99 per

cent of the stoker manufacturers of the country, to improve the quality of their product and of the service rendered to customers. The standard for membership is high and concerns must meet this standard to secure admission.

THE CONSOLIDATION is announced of Westinghouse, Church, Kerr & Co., Inc., and Dwight P. Robinson and Co., Inc., under the name of Dwight P. Robinson & Co., engineers and constructors. General offices, 125 East 46th street, New York, with district offices in Chicago, Cleveland, Pittsburgh and Dallas. The officers of the new corporation are: Dwight P. Robinson, president; F. N. Gilmore, first vice-president; I. W. McConnell, vice-president; A. K. Wood, vice-president and treasurer; R. M. Henderson, vice-president, L. H. Bean, vice-president; H. H. Kerr, vice president, Chicago office, and W. L. Murray, secretary. The directors elected are: Paul D. Cravath, Cravath and Henderson, attorneys; Thomas N. Gilmore, first vice-president; Homer Loring, Loring and Company, Boston; Ira W. McConnell, vice-president; John P. McGinley, chairman, Chicago Pneumatic Tool Company; Harry T. Peters, president, The Fairbanks Company; Dwight P. Robinson, president; Edward R. Tinker, vice-president, Chase National Bank, and Arthur King Wood, vice-president and treasurer.

THE CHICAGO PNEUMATIC TOOL CO., New York, announces the election of Allan E. Goodhue as vice-president in charge of sales. Mr. Goodhue, since May 1, 1919, has been managing director of the company's English subsidiary, The Consolidated Pneumatic Tool Co., London, England; also director of European sales for the Chicago Pneumatic Tool Co.

Mr. Goodhue was formerly for a number of years connected with the sales department of the Midvale Steel Company and Midvale Steel and Ordnance Co., in Philadelphia, Chicago and Boston, leaving that company in March, 1918, to enter the service of the Government. From that time until Jan. 1, 1919, when he became connected with the Chicago Pneumatic Tool Co., he was manager of the steel and raw material section, Production Division, of the Emergency Fleet Corporation.

GRIFFENHAGEN & ASSOCIATES, LTD., have taken over the industrial engineering department of Arthur Young & Co. and will be located at 116 South Michigan Ave., Chicago. Their work will be the giving of advice to clients on matters of organization, devising and installing general and cost accounting systems and methods of production control and investigations of economy and efficiency in management.

FRED C. DEWEESE, who for several years has been chief engineer for the General Explosives Co., of Joplin, Mo., has resigned that position to become resident manager of the Western Utilities Co. with headquarters at Edgemont, So. Da.

AT A SPECIAL MEETING of the Board of Directors of S. K. F. Industries, Inc., held May 13, 1920, the resignation of B. B. Prytz, as president, was accepted; Mr. Prytz having been elected Managing Director of the Parent Company, with headquarters at Gothenberg, Sweden.

At the same meeting, F. B. Kirkbride, vice-president since the organization of the company was elected president to succeed Mr. Prytz.

THE ECONOMY FUSE & MFG. CO., of Chicago, has appointed F. L. Easton as district sales-manager of its Denver office, 205 Commonwealth Bldg., Denver, Colo. Mr. Easton succeeds R. M. Olsen, who resigned recently. Mr. Easton formerly was connected with the Economy Fuse & Mfg. Co., but more recently has been doing sales promotion work for the Gates Rubber Co.

WILLIAM R. MARSHALL has been appointed manager of the Industrial Division, New York Office of the Westinghouse Electric & Manufacturing Co., to succeed H. A. Pratt, who has resigned to become sales manager of the Atlantic Elevator Co., of New York.

B. V. E. NORDBERG, son of the pioneer engine and hoist builder, B. V. Nordberg, has been appointed sales-manager of the Nordberg Manufacturing Co., Milwaukee, Wis. H. W. Dow, former sales-manager, recently resigned to become vice-president and engineer of the Forest Products Chemical Co., Memphis, Tenn.

U. S. CIVIL SERVICE COMMISSION announces an examination, July 20, for research engineer to fill a vacancy at Watertown Arsenal, Watertown, Mass., at $3000 to $3600 a year, and vacancies in positions requiring similar qualifications, at these or higher or lower salaries. Competitors will be rated on education, experience, fitness, theses, reports and publications. Applicants must not have reached their forty-fifth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 2118, stating the title of the examination desired.

U.S. CIVIL SERVICE COMMISSION announces an examination, July 27, for freehand draftsman, to fill vacancies occurring in the Patent Office, Department of the Interior, Washington, D. C., and in positions requiring similar qualifications, at $1000 a year, or higher or lower entrance salaries. Appointees whose services are satisfactory may be allowed the temporary increase granted by Congress of $20 a month. Competitors will be rated on drawing and lettering, education, experience and fitness. Apply for Form 1312.

U.S. CIVIL SERVICE COMMISSION announces an examination, July 27, for mechanical and steam engineer, to fill a vacancy at the U. S. Ordnance Plant, South Charleston, W. Va., at $14 a day, and vacancies in positions requiring similar qualifications, at this or higher or lower rates of pay. Competitors will be rated on physical ability, education, training, experience and fitness. Applicants must not have reached their forty-fifth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Trade News

GOETZE GASKET & PACKING Co. has opened a branch office at 242 Lafayette street, New York City. At this address, the company maintains offices, sales and stock rooms and employs skilled service men to meet all requirements of the district.

THE REFINITE Co. announces that it has just acquired by purchase of the entire capital stock, ownership and control of the L. M. Booth Co., manufacturer of the Booth lime-soda water softener. The Refinite company manufactures a water softener utilizing a natural zeolite taken from its mines in South Dakota. The Booth system is designed particularly for railroads, municipalities and the larger steam power and central heating plants.

E. T. USTICK, JR., formerly with the Blue Bird Washing Machine Co., of St. Louis, has taken over the distribution of lighting plants manufactured by the Universal Products Co. of Sandusky, Ohio, and Oshkosh, Wis. Mr. Ustick has associated with him Wm. Attebury, formerly of the Mississippi Valley Trust Co., and has established an office at 416 Title Guaranty Bldg., St. Louis, Mo. He is distributor for Missouri territory tributary to St. Louis and the southern portion of Illinois.

ON APRIL 2 the stockholders of J. H. Williams & Co., and of the Whitman & Barnes Manufacturing Co., ratified the agreement providing for the consolidation of the wrench and drop-forging plants and business of Whitman & Barnes at Chicago and St. Catherines with J. H. Williams & Co.; the Whitman & Barnes Manufacturing Co. retain their twist drill and reamer business and will continue, as an entirely separate organization and on an extended scale, the manufacture of these tools at Akron, Ohio.

J. H. Williams & Co. was one of the first to enter the field of drop-forgings and drop-forge tools commercially. The business was founded in Flushing, L. I., as a partnership in 1882 by James H. Williams and Matthew Diamond, under the style of Williams & Diamond, later Williams & Brock. It located in Brooklyn in 1884, assumed its present name in 1887, and was incorporated in New York State in 1895. The Brooklyn works employ 750 persons, occupy 2 adjoining square blocks of city property, and contain about 197,000 sq. ft. of floor space. In 1914, the Buffalo works, an entirely new plant, began operation; they now employ over 1000 persons and comprise 47 acres with about 233,000 sq. ft. of floor space.

The Whitman & Barnes Manufacturing Co. was founded as a partnership in 1846 by Augustus Whitman and Alfred G. Page under the title, Page, Whitman & Co. In 1868, the Akron factory was built and, in 1877, the business was combined with that of George Barnes & Co., of Syracuse, N. Y., the enlarged concern assuming its present name—The Whitman & Barnes Mfg. Co. The St. Catherine's plant was acquired in 1882 and 11 yr. later the Chicago Works were built. They now consist of 45 acres of land, with 320,000 sq. ft. of floor space and are connected by private trackage with four railroads. They employ about 800 people.

The business will continue to be operated by those who have been continuously identified heretofore with the business of J. H. Williams & Co. and with the Chicago and St. Catherine's plants of The Whitman & Barnes Manufacturing Co.

THE HAYS SCHOOL of Combustion Engineering, of Chicago, has just prepared a new and unique book entitled "Opportunities for the Combustion Expert." One of the features of this book is that it gives some real concrete helps for the power plant and boiler room man. It relates in story form the experiences of an engineer, pointing out his weaknesses in the first place and then showing how those weaknesses were overcome through a more definite knowledge of the work he is doing every day.

This book also discusses in a general way just what the Hays School is doing in making every effort to promote the big idea of fuel conservation Considerable attention has been paid to the installation of mechanical apparatus to check the amount of fuel used and to prevent as much waste as possible. It is only within the last few years that steps have been taken to lay before the men themselves, who handle the fuel, an opportunity to realize what great opportunities there are for the man who knows the essential elements of combustion engineering, and to be able to apply them from a fuel saving standpoint. The combustion engineer today has a real opportunity.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING Co., East Pittsburgh, Pa., has issued a circular entitled, "Marine Equipment in the Fabricated Ship," which describes and illustrates geared-turbine machinery for the 9000-dead-weight ton cargo boats built by the Merchant Shipbuilding Corporation. The history leading up to the development of the fabricated ship is outlined and the method of fabrication is described. A general description of this type of vessel built by the Merchant Shipbuilding Corporation is given together with some of the more important dimensions. In addition, plan and vertical drawings of the ship are reproduced, the details of the propelling equipment being shown. Photographs and line drawings indicate the type of turbines used for these ships. Typical photographs show the operating platform and views of the engine room. Photographs of the shipyard of this corporation and typical ship views are also shown.

The detailed apparatus is exhaustively treated by means of written discussion, reproduced halftones and line drawings. The description of the reduction gears is especially interesting.

SPRAGUE flexible steel armored hose for industrial work is described in Sprague Electric Works Pamphlet No. B-3567, superseding No. 517.

WORTHINGTON Pump and Machinery Corporation announces the purchase from the Platt Iron Works, of Dayton, Ohio, of its drawings, patterns, jigs, templates, special tools, good-will and name, on the following lines of product: On mill machinery, suitable for the extraction of oil from all sorts of nut and seed products, comprising crushers, cookers, cake formers, presses, filters and pumps; hydraulic turbine and water wheel line, covering their entire line of hydraulic turbines and water wheels, horizontal and vertical, high and low head; feed water heaters, steel and cast iron, horizontal and vertical; high pressure air compressors for torpedo and other high pressure charging, cleaning and discharging.